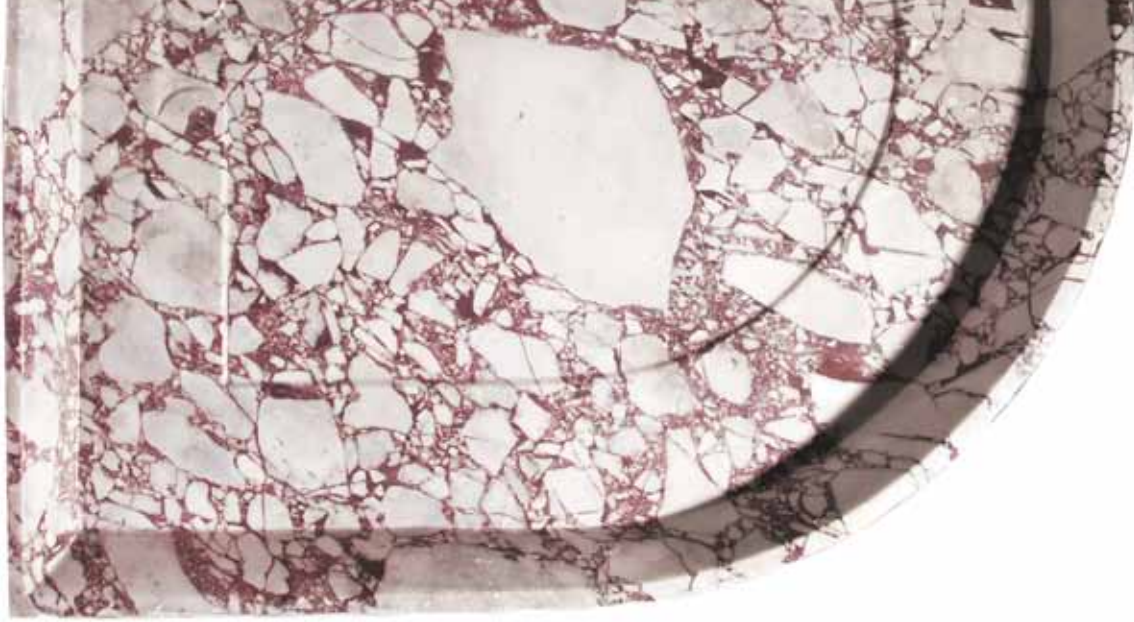

ASMOSIA XI

Association for the Study of Marble & Other Stones In Antiquity

XI INTERNATIONAL CONFERENCE

SPLIT, CROATIA, 18 - 22 MAY 2015

ABSTRACTS

FACULTY OF CIVIL ENGINEERING, ARCHITECTURE AND GEODESY

ACADEMY OF ARTS

Conference Organizers:

University of Split, Faculty of Civil Engineering, Architecture and Geodesy
University of Split, Academy of Arts
Archaeological Museum of Split
Split City Museum
Centre for Culture and Lifelong Learning Zlatna vrata

ASMOSIA XI

International Conference
Split, 18-22 May 2015

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ASMOSIA XI

Association for the Study of Marble
& Other Stones In Antiquity

XI International Conference

Abstracts

University of Split
Faculty of Civil Engineering, Arhitecture and Geodesy

Split. 2015

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ASMOSIA Proceedings

ASMOSIA I, 1988, N. HERZ, M. WAELKENS (eds.): Classical Marble: Geochemistry, Technology, Trade, Dordrecht/Boston/London,1988.

ASMOSIA II, 1990, M. WAELKENS, N. HERZ, L. MOENS (eds.): Ancient Stones: Quarrying, Trade and Provenance – Interdisciplinary Studies on Stones and Stone Technology in Europe and Near East from the Prehistoric to the Early Christian Period, Leuven 1992.

ASMOSIA III, 1993, Y. MANIATIS, N. HERZ, Y. BASIAKOS (eds.): The Study of Marble and Other Stones Used in Antiquity, London 1995.

ASMOSIA IV, 1995, M. SCHVOERER (ed.): Archéomatéiaux – Marbres et Autres Roches. Actes de la IVème Conférence Internationale de l'Association pour l'Étude des Marbres et Autres Roches Utilisés dans le Passé, Bordeaux-Talence 1999.

ASMOSIA V, 1998, J. HERRMANN, N. HERZ, R. NEWMAN (eds.): ASMOSIA 5, Interdisciplinary Studies on Ancient Stone – Proceedings of the Fifth International Conference of the Association for the Study of Marble and Other Stones in Antiquity, Museum of Fine Arts, Boston, June 1998, London 2002.

ASMOSIA VI, L. LAZZARINI (ed.): Interdisciplinary Studies on Ancient Stone – ASMOSIA VI, Proceedings of the Sixth International Conference of the Association for the Study of Marble and Other Stones in Antiquity, Padova 2002.

ASMOSIA VII, 2003, Y. MANIATIS (ed.): Actes du VIIe colloque international de l'ASMOSIA, Thasos 15-20 septembre 2003, Proceedings of the 7th International Conference of Association for the Study of Marble and Other Stones in Antiquity, Thassos 15-20 septembre 2003, BCH supplement 51, Athènes 2009.

ASMOSIA VIII, 2006, P. JOCKEY (ed.): Leukos Lithos, marbres et autres roches de la mediterranée Antique: etudes interdisciplinaires, Paris 2009.

ASMOSIA IX, 2009, A. GUTIERRÉZ-GARCIA, P. LAPUENTE, I. RODÁ (eds.): Interdisciplinary studies on ancient stone. Proceedings of the IX ASMOSIA Conference, Tarragona 2012.

ASMOSIA X, 2012, P. PENSABENE, E. GASPARINI (eds.): Interdisciplinary Studies on Ancient Stone. Proceedings of the X ASMOSIA International Conference, Rome 2015.

ASMOSIA XI
SPLIT, CROATIA 18-22 MAY 2015
PROGRAM

MONDAY, 18 May 2015
Auditorium Zlatna vrata

8.00-9.00 Registration

9.00-9.15 Official opening of the Conference

Applications to Specific Archaeological Questions – Use of Marble
Chairman: Y. Maniatis

9.15- 9.30
T. Kozelj, M. Wurch-Kozelj
Three Marble Blocks with Inscriptions from Thassian Agora - New Studies

9.30- 9.45
C. Ertel
The Use of Coloured Marble in the Basilica Aemilia in Rome (Italy)

9.45-10.00
S. J. Barker, J. Clayton Fant
The Stone Décor at the Villa Arianna and Villa San Marco (Castellammare di Stabiae)

10.00-10.15
M. David, S. Succi, M. Turci
First Remarks about the Pavement of the Newly Discovered Mithraeum of Multicoloured Marbles at Ostia and New Investigations on Roman and Late Roman White and Coloured Marbles from Block IV, IX

10.15-10.30
S. J. Barker, S. Perna
'Alabaster': Quarrying and Trade in the Roman World. Evidence from Pompeii and Herculaneum

10.30-11.00 Discussion

11.00-11.30 COFFEE BREAK

Applications to Specific Archaeological Questions – Use of Marble
Chairman: G. Koch

11.30-11.45
C. Passchier, S. Wex, S. Ilhan
The Use of Cipollino Verde from Ephesos to Obtain Information on Structural Geology and Roman Sawing Techniques

11.45-12.00
S. Ardeleanu
Giallo antico in Context. New Stratigraphic Data from the Western Mediterranean (2nd c. BC-1st c. AD)

12.00-12.15
A. Gutiérrez Garcia-M., H. Royo Plumed, S. González Soutelo
New Data on Spanish Marbles: the Case of *Gallaecia* (NW Spain)

12.15-12.30
D. Segal
Testimonies of Relics of Imported Colored Marble in the Land of Israel

12.30-12.45
B. Burrell
Multiple Reuse of Imported Marble Pedestals at Caesarea Maritima in Israel

12.45-13.00
P. A. Butz
The Marble Dedication of Komon, Son of Asklepiades, from Egypt:
Material, Provenance, and the Reinforcement of Meaning

13.00 - 13.30 Discussion

13.30 - 15.00 PAUSE

Applications to Specific Archaeological Questions – Use of Marble
Chairman: L. Miraj

15.00-15.15
L. Musso, L. Buccino, M. Bruno, D. Attanasio, W. Prochaska
Marble and Sculpture at Lepcis Magna (Tripolitania, Libya): a Preliminary Study Concerning Origins and Workshops

15.15-15.30
E. Neri, R. Bugin, S. Gazzoli
Marble wall Decorations from the Imperial Mausoleum (4th c.) and the Basilica of San Lorenzo (5th c.) in Milan: An Update on Colored Marbles in Late Antique Milan

15.30-15.45
A. Polgár-Nyerges
Marble Decoration from the Late Roman Proconsul's Palace in Savaria

15.45-16.00
F. Berti, D. Peirano
Iasos and the Iasian Marble Between Late Antique and Early Byzantine Times

16.00-16.15
D. A. McColl
Christian Sculptures from a Phrygian Quarry?

16.15-16.45 Discussion

16.45 - 17.15 COFFEE BREAK

Applications to Specific Archaeological Questions – Use of Marble
Chairman: M. Lombardo

17.15-17.30
O. Rodríguez, E. Ontiveros, L. Loza, R. Taylor, J. Beltrán, A. Rodríguez
The Value of Marble: Contexts of Reuse of Architectural Materials in Late Antique Seville (Goyeneta, 17). Archaeological Analysis and Petrographic Characterization

17.30-17.45
M. Fischer, Y. Maniatis, D. Tambakopoulos
Recycling of Marble: Apollonia-Arsuf (Israel) as a case study

17.45-18.00
P. D. De Staebler
The Re-use of Monolithic Columns in the Invention
and Persistence of Roman Architecture

18.00-18.15
N. Toma
Standardised Production of Monolithic Shafts. New Evidence Concerning the Imperial Building Industry

18.15-18.30
L. Pedroni
Amethystus: Ancient Properties and Iconographic Selection

18.30-18.45
H. N. Parker
"One Carnelian Against all Evil and Envy": A Grammar of Magic Stones

18.45-19.15 Discussion

19.15 Exhibition: Marmore laudata Brattia & welcome drink (Split City Museum)

TUESDAY 19 May 2015
Auditorium Zlatna vrata

Special Theme Session: "The use of Marble and Limestone in the Adriatic Basin in Antiquity"
Chairman: S. Kane

9.00-9.15
M. Lombardo, I. Radić Rossi
The Use of Marble and Limestone for Greek Inscriptions in Ancient Dalmatia and a new Document from Vranjic Mentioning Alexander".

9.15-9.30
G. Koch
Sarcophagi of Roman Dalmatia, Material – Provenance - Workmanship

9.30-9.45
N. Cambi
Production of Local Limestone Statuary and Sarcophagi in Dalmatia

9.45-10.00
K. Marasović, V. Marinković
Marble Revetment of Diocletian's Palace in Split

10.00-10.15
B. Matulić, K. Bosnić, D. Mudronja
The use of Limestone and Marble as Mosaic Material of Diocletian's Palace

10.15-10.30
G. Nikšić
Restoration of the Peristyle of Diocletian's Palace in Split

10.30–10.45
E. Lozić, I. Rižnar
The Use of Limestone in the Roman Province of Dalmatia

10.45-11.00 Discussion

11.00 - 11.30 COFFEE BREAK

Special Theme Session: "The use of marble and limestone in the Adriatic basin in Antiquity"
Chairman: L. Lazzarini

11.30-11.45
L. Miraj
The Byzantine Round Forum of Dyrrachium

11.45-12.00
C. Previato
Aurisina's Limestone in the Roman Age: From Karst Quarries to the Cities of the Adriatic Basin

12.00-12.15
R. Matijašić, K. Buršić-Matijašić
The Extraction and use of Limestone in Istria in Antiquity

12.15-12.30
R. Bužančić
The Stone of Ancient Salona and its Province

12.30-12.45
M. Parica
The Remains of Infrastructural Objects of the Ancient Quarries on Zadar Islands (Croatia)

12.45-13.00
M. Jarak
Notes on Early Christian Ambos and Altars in the Light of Fragmentarily Preserved Monuments from the Islands of Pag and Rab

13.00-13.15
D. Matetić Poljak, Đ. Gobić Bravar
The Marbles in the Chapel of the Blessed John of Trogir in the Cathedral of Saint Lawrence in Trogir

13.15-13.45 Discussion

13.45 - 15.15 PAUSE

15.15 - 17.00 **Poster session I** (Split City Museum)
Applications to Specific Archaeological Questions, Provenance Identification I and II, Advances in Provenance Techniques, Methodologies and Databases

17.00 Visit to Salona and Archaeological Museum of Split

19.00 Presentation of ASMOSIA X Conference Proceedings (Archaeological Museum of Split)

WEDNESDAY 20 May 2015
Auditorium Zlatna vrata

Provenance Identification I: (Marble)
Chairman: J. J. Herrmann

9.00-9.15
S. H. Pike, L. Lambrinou
The Parthenon's Quarry Quandry – Looking Inside the Pentelic Source

9.15-9.30
A. D. Kollar
The Pentelic Marble of the Carnegie Museum of Pittsburgh, Pennsylvania U.S.A.

9.30-9.45
O. Palagia, Y. Maniatis, D. Tambakopoulos
New Scientific Investigation of the Provenance of the Marble of the Sounion Kouroi and a fresh Attempt of Assignment of Statues to Bases

9.45-10.00
H. Aurigny, P. Blanc, A. Blanc, D. Braunstein, J.-L. Martinez
New Investigations on the Fragments of White Marble Statues in the Museum of Delphi

10.00-10.15
L. Laugier, P. Blanc, A. Blanc
The Winged Victory of Samothrace: New Datas About the Different Marbles Used for the Monument from the Sanctuary of the Great Gods

10.15-10.30
D. Andrianou, L. Lazzarini
Initial Archaeometric Studies of the Marmaritsa Marble Quarry at Maroneia and Twelve Thracian Funerary reliefs in the Komotini Museum (Greece)

10.30-10.45
P. Pensabene
Sleeping Hermaphrodites and Maenads: Production Centres and Quarry Marks

10.45-11.00 Discussion

11.00-11.30 COFFEE BREAK

Provenance Identification I: (Marble)
Chairman: P. Lapuente

11.30-11.45
N. Cahill, L. Lazzarini
The Quarries of the Mağara Deresi and the Marble of the Temple of Artemis at Sardis

11.45-12.00
L. A. Çakmak, S. H. Pike, E. Hamilton
Stable Isotope Analysis of the White Marble Sculptures from the Saint Louis Art Museum

12.00-12.15
D. Tambakopoulos, Y. Maniatis, Th. Stefanidou-Tiveriou, E. Papagianni
Provenance Study of Roman Sarcophagi from Nicopolis, Epirus, Greece:
The Question of Local Production versus Marble Origin

12.15-12.30
J. Leidwanger, S. H. Pike, A. J. Donnelly
Revisiting the Origin and Destination of the Late Antique Marzamemi 'Church Wreck' Cargo

12.30-12.45
A. van den Hoek, D. Attanasio, J. J. Herrmann
Roman Monolithic Fountains and Thasian Marble

12.45-13.00
I. Bald Romano, H. Rupprecht Goette, D. Attanasio, W. Prochaska
Two Imperial Monuments in Puteoli: Use of Proconnesian Marble in the Domitianic and Trajanic Periods in Campania

13.00-13.30 Discussion

13.30 - 15.00 PAUSE

Provenance Identification I: (Marble)
Chairman: P. Pensabene

15.00-15.15
F. Berti, L. Lazzarini
An Archaeometric Study of Parian Marble Artefacts Imported to the Adriatic Etruscan sites of Spina and Marzabotto

15.15-15.30
J. J. Herrmann, D. Attanasio
Thasian Connections Overseas: Sculpture in the Cyrene Museum (libya) Made of Dolomitic Marble from Thasos

15.30-15.45
P. Lapuente, T. Nogales-Basarrate, H. Royo Plumed, M. Brilli
Grey and Greyish Banded Marbles from the Estremoz Anticline in Lusitania

15.45-16.00
H. Royo Plumed, P. Lapuente, J. A. Cuchí, M. Brilli
Updated Characterization of the White and Greyish Saint-Béat Marbles. Parameters of its Discrimination from Classical Marbles

16.00 - 16.15
F. Limão, J. Carvalho, J. Mirão, L. Lopes, V. Lisboa
The Capital of Tróia (Portugal): The Gateway to the Understanding of Architecture, Decoration and Materials in the Settlement of Tróia During Antiquity

16.15 - 16.30
R. H. Tykot, L. R. Adams, J. Balen, B. Bass, P. Della Casa, S. Forenbaher, T. Kaiser, D. Komšo, E. Podrug
The Use of "Other Stones in Antiquity" in Croatia: Long Distance Acquisition of Obsidian in the Neolithic Period

16.30 - 17.00 Discussion

17.00 - 17.30 COFFEE BREAK

Provenance Identification II: (Other Stones)
Chairman: W. Prochaska

17.30-17.45
M. Cisneros, J. Gisbert
Ornamental Rocks Used in the Architecture and Epigraphy of Labitolosa (Conventus Caesaraugustanus, Provincia Hispania Citerior)

17.45-18.00
R. Dreesen, C. Coquelet, E. Goemaer, G. Creemers, G. Vynckier, A. Vanderhoeven
Geological Provenance of Roman Building and Ornamental Stones within the Civitas Tungrorum (Eastern Belgium)

18.00-18.15
G. Kremer, I. Kitz, B. Moshammer, M. Heinrich, E. Draganits
Stone Monuments from Carnuntum and Surrounding Areas (Austria) – Petrological Characterization and Quarry Location in a Historical Context

18.15-18.30
B. Djurić, S. Kele, I. Rižnar
The Budakalász Travertine Production in Pannonia Inferior and Moesia Superior

18.30-18.45
B. Migotti
Aspects of Characterisations of Stone Monuments from Southern Pannonia

18.45-19.15 Discussion

THURSDAY 21 May 2015
Auditorium Zlatna vrata

Provenance Identification I: (Marble)
Chairman: R. H. Tykot

9.00-9.15
W. Prochaska, D. Attanasio, M. Bruno
Unraveling the Carrara – Göktepe Entanglement

9.15-9.30
D. Attanasio, M. Bruno, W. Prochaska, A.B. Yavuz
The Marble of Roman Imperial Portraits

9.30-9.45
J. Pollini, P. Lapuente, J. Podany
A New Roman Imperial Relief Said to be from Southern Spain: Problems of Style, Iconography, and Marble Type in Determining Provenance

9.45-10.00
T. Koester, E. Pernicka
Provenance Analysis of 'Calcite-Alabaster' Vessels from Qatna, Syria, by NAA

10.00-10.15
L. Leroux, W. Kloppmann, P. Bromblet, C. Guerrot, A.H. Cooper, P.Y. Le Pogam, D. Vingtain
Tracing Alabaster (gypsum or anhydrite) Artwork Using Trace Elements Analysis and a Multi-Isotope Approach (Sr, S, O)

10.15-10.30
K. Al-Bashaireh
Provenance Investigation of White and Green Marble Architectural Elements from Abila Archaeological Site, North Jordan.

10.30-10.45
A. Rohatsch, B. Hodits, B. Moshammer
Coloured Marble Panels from the Thermae of Carnuntum (Austria)

10.45-11.00
B. Hodits, M. Kronberger, S. Insulander, M. Mosser, A. Rohatsch
Stone Objects from Vindobona (Austria) – Petrological Characterization and Provenance of Local Stone in a Historico-Economical Setting

11.00-11.15
V. Ruppienė
Revetments from Colonia Ulpia Traiana, Xanten (Germany)

11.15 - 11.45 Discussion

11.45 - 12.15 COFFEE BREAK

Pigments and Paintings on Marble
Chairman: A. van den Hoek

12.15-12.30
V. Brunet-Gaston, C. Gaston
Painting Conservation and Sculptures of two Gallo-Roman Temples in Picardy: Champlieu and Pont-Sainte-Maxence

12.30-12.45
E. Siotto
The use of Colour in Roman Marble Sarcophagi

12.45-13.00
T. Borovac, A. Gluhan, N. Radošević
Faux Marbling Motifs in Early Christian Frescoes in Central and South Dalmatia

13.00-13.15
J. Powers, M. Abbe, M. Bushey, S. Pike
An Investigation of Gilding, Repairs and Restorations:
The Case Study of a Portrait of Antinous in the San Antonio Museum of Art

13.15-13.30 Discussion

13.30 - 15.00 PAUSE

15.00 - 16.45 **Poster session II** (Split City Museum)
Quarries and Geology, Stone Properties, Weathering Effects and Restoration, Pigments and Paintings on Marble, Special Theme Session

16.45 - 18.30 Visit to Historical Core of Split with Diocletian's Palace

18.30 - 19.00 Asmosia members meeting

FRIDAY 22 May 2015
Auditorium Zlatna vrata

Quarries and Geology
Chairman: A. Gutiérrez Garcia-M.

9.00-9.15
Y. Maniatis, D. Tambakopoulos, E. Papavassiliou, K. Bairami
Lartios Lithos of Rhodes Island: Scientific Characterization and Possible Uses and Exports

9.15-9.30
M. Bruno, D. Attanasio, W. Prochaska, A.B. Yavuz
Euromos of Caria: The Origin of an hitherto Unknown Grey Veined Stepped Marble of Roman Antiquity

9.30-9.45
A. Oğuz Alp
A Local Roman Quarry and Gravestele Workshop in Phrygia (Turkey)

9.45-10.00
A. Arslan
Ancient Quarries at Kurşunlu in Lycaonia (Turkey)

10.00-10.15
T. Saner, G. Mater, E. Denktas
Polychromy in Larisaean Quarries and its Impact on Architectural Conception

10.15-10.30
A. Zara
The Euganean Trachyte, a Stone Source of Regio X and its Use in Northern Italy

10.30-11.00 Discussion

11.00 - 11.30 COFFEE BREAK

Quarries and Geology
Chairman: D. Attanasio

11.30-11.45
A. Younes, M. Gaied, W. Gallala
Geoarchaeological Study of the Green Schist Stone of Jebel El Hairech (North-West of Tunisia)

11.45-12.00
Y. Rezkallah, R. Marmi
Building Materials and the Ancient Quarries at Thamugadi (East of Algeria), Case Study: Sandstone and Limestone

12.00-12.15
H. Güney
A Discovery of a Limestone Quarry in Northern Choria Considiana (Phrygia)

12.15-12.30
D. Braunstein
The Different Steps of the Rough-Hewing on a Monumental Sculpture at the Greek Archaic Period : The Unfinished Kouros of Thasos

12.30-12.45
S. Moureaud
A Methodological Point on the Techniques of Copy in Greco Roman Sculpture

12.45-13.00
M. Buzov, V. Lalošević
"How do You, Brother, Break Your Chisel?" – Picture of Everyday Life of Ancient Stonemasons

13.00-13.30 Discussion

13.30 - 15.00 PAUSE

Advances in Provenance Techniques, Methodologies and Databases
Chairman: S. H. Pike

15.00-15.15
A. Àlvarez, A. de Mesa, A. Gutiérrez Garcia-M., P. Lapuente, I. Rodà, H. Royo Plumed
Marmor lapisqve, a New Web Database Catalogue. A reference of Hispanic Stone Materials Used in Antiquity

15.15-15.30
R. Přikryl, Z. Weishauptová, M. Racek, J. Přikrylov
Analytical Protocol for the Provenance Determination of Opuka - a Clayey Calcite-Rich Siliceous Mudstone Used Since Antiquity in Bohemia

15.30–15.45
D. Wielgosz, F. Antonelli, M. Bojanowski, S. Cancelliere, D. Erkanol, M. Gładki, A. Jarmek, L. Lazzarini, M. Ruszkowski, N. Şentürk
Dokimeion AD 2014
The First Season of the Project "Marmora Asiatica Towards Archaeopetrology in Poland"

15.45-16.00
P. Onuk, W. Prochaska
How Insitu Laser Ablation ICP-MS Analysis Can Help in the Provenance Analysis of Isotopically Very Similar Marbles

16.00-16.15
K. Csorba, L. Barancsuk, B. Székely, J. Zöldföldi
GrainAutLine – A Supervised Grain Boundary Extraction Tool Supported by Image Processing and Pattern Recognition

16.15-16.45 Discussion

16.45 Closing of he Conference

19.00 Conference banquet (Split City Museum)

SATURDAY 23 May 2015
9.00 - 18.00 Excursion to Island of Brač

POSTER LIST

TUESDAY 19 May 2015

15.15-17.00 **Poster session I** (Split City Museum)
Applications to Specific Archaeological Questions, Provenance Identification I and II, Advances in Provenance Techniques, Methodologies and Databases

P. Pensabene, E. Gasparini
The Trade of Small-Scale Statues in the Roman Mediterranean: A Case Study from Alexandria

A. van den Hoek, J. J. Herrmann
Breccia Corallina and Paul the Silentiary

S. Ahrens, F. Van Keuren, J. E. Cox, G. Scardozzi, M. Brilli, Y. Maniatis, D. Tambakopoulos
Two Dokimeion Sarcophagi from Hierapolis of Different Marbles

N. Toma
Aphrodisias and the Regional Marble Trade. The Case of the Scaenae frons of the Theatre at Nysa

M. Vitti, M. Bruno, D. Attanasio
Athens, National Archaeological Museum: Analysis of Sculptures from the Roman Collection

V. Barbin, J. J. Herrmann, A. Mentzos, A. van den Hoek
Calcitic Marble from Thasos in Nea Anchialos (Magnesia, Central Greece) and Thessaloniki

M. Dzwoniarek
Preliminary Investigation into the Stone Materials from Nea Paphos (Cyprus)

J. Bonetto, M. Bueno, N. Mareso
Polycrome Marbles from the Pythion's Theatre in Gortyna (Crete)

J. Zöldföldi, C. Alexandrescu, H. Taubald
Provenance Analyses of Marble Used in the Ancient Site of Troesmis (Turcoaia, Tulcea County, RO) and its Territorium (1st – 4th century A.D.)

W. Prochaska, M. Zivic
The Marbles of the Sculptures of Felix Romuliana in Serbia

B. Djurić, D. Jovanović, W. Prochaska
Stones of Galerius' Villa of Felix Romuliana (Gamzigrad, Serbia)

F. Antonelli, F. Colivicchi, S. Cancelliere, L. Lazzarini
The Late Hellenistic Funerary Reliefs of the Archaeological Museum of Naples: Historical, Artistic and Archaeometric Aspects

D. H. Abramitis, J. J. Herrmann
Reassessment of the Reuse of an Architectural Block for the Manufacture of a Strigilated Sarcophagus in Naples

R. Bugini, L. Folli, M. Solito
Coloured Marbles in the Neapolitan Architecture (16th and 17th centuries): The Church of Santi Severino e Sossio

F. Antonelli, J. Bonetto, M. G. Fabrini, L. Lazzarini
The Use of White Marbles in Roman Gortyn (Crete) as shown by the Evidence of Archaeometric Analyses

M.Brilli, F. Giustini, P. Pensabene
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C. Beltrame, L. Lazzarini, S. Parizzi
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The Marble Capitals Re-used in the Crypt of the Cathedral of Otranto (Lecce, Southern Italy): Identification and Determination of the Provenance

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Reuse of the Marmora from the Late Roman Palatial Building at Carranque in the Visigoth Necropolis

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M. E. Peroschi
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THURSDAY 21 May 2015

15.00-16.45 **Poster session II** (Split City Museum)
Quarries and Geology, Stone Properties, Weathering Effects and Restoration, Pigments and Paintings on Marble, Special Theme Session

F. Bianchi, D. Attanasio, W. Prochaska
Achitectural Decoration of the Imperial Agora's Porticoes at Iasos

P. Pensabene, J. Á. Domingo
The Distribution of Troad Columns as Evidence for Reconstructing the Production System

M. Vaxevanopoulos, M. Vavaliou, V. Melfos, G. Economou
Quarries of an Ancient Town Close to the Modern City of Volos, Thessaly, Central Greece

M. Vavaliou, M. Vaxevanopoulos, V. Melfos, G. Economou
Recording and Mapping Ancient Quarries in Thessaly, Central Greece

G. Quarta, M.T. Giannotta, F. Giuri, P. Sansò, A. Vitale
Identification of an Ancient Limestone Quarry on the Ionian Coast of Southern Apulia (Southern Italy): Rock Characterization and New Data About its Exploitation over Time

E. Piccardi
Saxa sacra et lapides excavatas atque incisas. Stone Quarries Areas: Forms of Sacredness Between Political Power and Religious Expressions in the Roman Mid-Northern Tyrrhenian Sea

J. Atienza Fuente
The Local Quarries of the Ancient Roman City of Valeria (Cuenca, Spain)

I. López García, J. M. Compaña Prieto
Historic Exploitation of Marmora in the Osuna-Estepa Quarries (Seville, Spain)

A. Alvarez
The Stone and Ancient Quarries of the Montjuïc Mountain (Barcelona, Spain)

A. Gutiérrez Garcia-M., J. López Vilar
New Insights on the Chronology, Exploitation and Life of the Roman Quarry of El Mèdol (Tarragona, Spain)

M. Gaied, A. Younes
The Alteration of the Tyrrhenian Stone Used in the Ancient Fortifications in Sousse (Tunisia)

M. Serena Vinci
Notae Lapicidinarum: Documentation and Analysis of Quarry Marks from Provincial Forum of Tarraco

P. C. LaPorta
Millstone Quarries of the Shawangunk Ridge, Lower Silurian Metaconglomerate, New York, U.S.A.

N. Toma
A Corinthian Capital of 'Pietra di Aurisena' on Proconnesos. A prototype for Quarry Production or a Stray Find?

B. Russell
Labour Forces at Imperial Quarries

B. Matulić, K. Bosnić
Social Position of the Craftsmen Inside the Stone and Marble Processing Trades in the Light of Diocletian's Edict on Prices

S. Violante
Coloured Marble Slabs with Gold Leaf Decorations from the Gorga Collection

M. Apostolopoulou, E. Drakopoulou, M. Karoglou, A. Bakolas
Methods of Consolidation and Protection of Pentelic Marble

E. Playà, M. Beltran, M. Artigau, P. Arroyo, A. Guinea
Formation of Iron Patinas on Alabaster Surfaces: Santa Maria de Poblet Monastery, Tarragona, NE Spain

F. Mariottini, G. Vignaroli, M. Mariottini
Schists and Pigments from Ancient Swat (Khyber Pukhtunkhwa, Pakistan)

M. Miliša
Polychrome Ancient Stone Sculpture, Red Pigment as the Most Common Witness of the Original Appearance

M. Bruno
Unknown Quarry Inscriptions from the Bacakale Quarry at Docimium (Turkey)

V. Zović
Decoration of Limestone Stelae from Roman Colony of Parentium and its Territory

M. Pavletić
Antique Marbles from the Roman Villa in Verige Bay

Đ. Gobić-Bravar
Marble Slabs Used at the Archaeological Site of Sorna near Poreč Istria – Croatia

M. Glavičić, U. Stepišnik
The Impact of Local Geomorphological and Geological Features of the Area for the Construction of the Burnum Amphitheatre

I. Alduk
The Quarries of Salona

J. Bezak
Traces of Stone Exploitations Under the Sea - The Ancient Quarry Site in Srebrena Bay on the Island of Vis

M. Parica, I. Borzić
Island of Korčula – Importer and Exporter of Stone in Antiquity

I. Lipanović, V. Marinković
Quarries of the Korčula Archipelago

J. T. Katunarić Krijakov
Roman Limekiln in the Bay of sv. Ivan Kornetski nearby Umag, Croatia

Abstracts

REASSESSMENT OF THE REUSE OF AN ARCHITECTURAL BLOCK FOR THE MANUFACTURE OF A STRIGILATED SARCOPHAGUS IN NAPLES

Dorothy H. ABRAMITIS,[1] John J. HERRMANN[2]

[1]Sherman Fairchild Center for Objects Conservation,
The Metropolitan Museum of Art, New York, New York, United States
(de.abramitis@metmuseum.org)
[2]Museum of Fine Arts, Boston, Dedham, Massachusetts, United States
(jherrmannjr@comcast.net)

Keywords: sarcophagus, salvaged marble, saw cuts

Visual examination of the Museo Nazionale Archeologico, Naples *Strigilated lenos with Cupids holding birds at the corners* and its *lid with sea monsters* reveals strong evidence that the lid was cut from the lower back of this marble sarcophagus. Observation of the veins on the saw-cut section of both the lid and the box exhibit with striking clarity the original orientation of the two sections. In *ASMOSIA 9*, "Late Roman Sarcophagi in Central Italy Made from Scavenged Blocks", John Herrmann mistakenly categorized this sarcophagus as manufactured from salvaged blocks, however reassessment of the saw-cut surfaces finds the manner of manufacture is consistent with unfinished sarcophagi, rather than a reused architectural fragment. Interestingly, the Naples example shows a different location of the lid prior to being cut from the box than is evident in the *Lion Hunt sarcophagus* in the Ostia Museum (inv. 36231), noted in John Herrmann's *ASMOSIA X* article ("Saw Cuts on Marble Sarcophagi: New York and Ostia"). Photographs of the back of the Naples sarcophagus will be used to illustrate the finding along with a brief explanation. A diagram will be included to explain the difference in the production of the lids of both the Naples and Ostia sarcophagi.

TWO DOKIMEION SARCOPHAGI FROM HIERAPOLIS OF DIFFERENT MARBLES

Sven AHRENS,[1] Frances VAN KEUREN,[2] Julia E. COX,[3]
Giuseppe SCARDOZZI,[4] Mauro BRILLI,[5] Yannis MANIATIS,[6]
Dimitris TAMBAKOPOULOS[6]

[1]Norwegian Maritime Museum, Oslo, Norway (sven.ahrens@marmuseum.no)
[2]Lamar Dodd School of Art, University of Georgia, Lawrenceville, Georgia, United States (francesvankeuren@gmail.com)
[3]Department of Geology, University of Georgia, Athens, Georgia, United States (juliaec@uga.edu)
[4]IBAM-CNR, Lecce, Italy (g.scardozzi@ibam.cnr.it)
[5]IGAG-CNR, Rome, Italy (mauro.brilli@igag.cnr.it)
[6]Laboratory of Archaeometry, Institute of Nanoscience and Nanotechnology, NCSR "Demokritos", Attiki, Greece (y.maniatis@inn.demokritos.gr; d.tambakopoulos@inn.demokritos.gr)

Keywords: Sarcophagi, Hierapolis, Dokimeion

Samples were taken and analyzed in the first project of its kind, from 14 Roman sarcophagi and one ostotheca from Hierapolis in Phrygia. Stable isotopic and petrographic analyses were conducted at three laboratories. The analysis results for one socle from a garland sarcophagus of Dokimeion type were difficult to interpret. Unexpectedly, the large maximum grain size (5.5 mm) ruled out the identification of the marble as Dokimeian. No other marble in the vicinity of Hierapolis was so large-grained, until the recent sampling and analysis of the marbles from Marmar Tepe (located about 3 km north of Hierapolis) and Gölemezli (located about 14 km northwest of Hierapolis) revealed that these quarries were the most likely provenances.

Another fragmentary sarcophagus of the same type of garland sarcophagus, with the same combination of moldings on the socle—with the motifs of garland leaves, inverted palmettes, beads and reels, and a meander, along with sphinxes at the corners of the socle, proved to be of the expected Dokimeion marble. Several other garland sarcophagi with the same type of socle are from the vicinity of Hierapolis in the Lycos Valley—a region linked to the Meander River, a possible highway for the transport of Dokimeion marble, by the Lycos River. Given the apparent easy accessibility of

Dokimeion marble, it is possible that garland sarcophagi, both of Dokimeion and of local marble, were produced, or at least finished, in the Lycos Valley. This supposition is important for the history of Dokimeion sarcophagi, because of the early date of sarcophagi with this type of socle, i.e. ca. 120-140 AD. This date is supported by the seemingly Hadrianic date of the naturalistic fragmentary Gorgons' heads, which were once placed above the garland swags on, probably, the same sarcophagus that tested to be of Dokimeion marble.

PROVENANCE INVESTIGATION OF WHITE AND GREEN MARBLE ARCHITECTURAL ELEMENTS FROM ABILA ARCHAEOLOGICAL SITE, NORTH JORDAN

Khaled AL-BASHAIREH

Department of Archaeology, Yarmouk University, Irbid, Jordan
(khaledsm@email.arizona.edu)

Keywords: Abila, Northwest Jordan, White and green marble, Isotopes, Petrography, Proconessos Turkey, Carystus Greece

This research aims at characterizing and determining the provenance of white and green marble samples collected from architectural elements from Abila archaeological site (northern part of Jordan) and sheds light on the marble trade in the Jordan area. The samples were examined macroscopically and subjected to a series of analytical techniques including optical petrography, X-ray diffraction (XRD), cathodoluminescence and mass spectrometry (MS). The data obtained were compared to the main reference databases of known Mediterranean marble quarries exploited in Antiquity. The most probable major source of most of the medium-large grain samples is Proconnesus, Marmara, Turkey. Some samples are probably Parian (1-2), Paros, Greece. The most probable source of the green marble is Karystos, Greece. Although some of the samples might be reused, the used and reused marbles show that Proconnesus-1 and Karystos were the main sources of the white and green (cipollino) marbles during the Roman and Byzantine times.

THE QUARRIES OF SALONA

Ivan ALDUK

Conservation Department in Imotski, Imotski, Croatia
(alduk.ivan9@gmail.com)

Keywords: Salona, quarries, field survey

The paper deals with the functioning of the site known as "Gradina kod Uvodića" at Klis-Kosa. This site has been known since the end of the 19th century when the inscription of Lucius Egnatius Clemens was published in CIL. However, it has never been treated in a more detailed way, although minor archaeological researches started in the 1980s, unfortunately, soon to be terminated. During these researches, documentation of the site was completed. Owing to this, today we know about some parts of the site which, for 30 years now, are no longer preserved. Given the archaeological context and character of the site (water supply, roads, epigraphy, other archaeological finds), it is assumed to have been a residential and sacral complex belonging to the stone quarries on the western slopes of the Mosor mountain. The big blocks of stone from this area were used for building various structures in Salona (streets, Capitolium, forum, theatre, early necropolis, city walls and gates), especially in the 1st century AD, during the formation of the city as the Roman colony and capital of the province of Illyricum - Dalmatia. The author also tries to relate assumed quarries on the Mosor mountain with other archaeological finds in Salona and with known quarries in the greater city area (Trogir, Brač) and beyond.

A LOCAL ROMAN QUARRY AND GRAVE STELE WORKSHOP IN PHRYGIA (TURKEY)

Ahmet Oğuz ALP

Faculty of Humanities Yunus Emre Kampüsü, Anadolu University, Eskişehir, Turkey
(aoalp@anadolu.edu.tr)

Keyword: Phrygia, Roman Quarries, Grave stele

The ancient quarries, which are thought to be exploited in Roman and Byzantine Periods have been discovered during the excavations and surveys carried out in the past years at the Village of Başara located approximately 100 km southeast of Eskişehir. Three different quarry sites were found where extraction traces are still to be seen on metamorphic bedrock vicinity of the ancient settlement. Dark grey coloured marbles were used for the construction of two Byzantine churches unearthed at the excavations and the grave steles found by us, as well as the inscriptions which have been recorded by the researchers such as W.M. Ramsay, Cox, Waelkens, Thomas Drew-Bear and T. Lochman since the 19th century at Başara. The fact that the votive stele, discovered at the excavations and naming the settlement (*Ατυιην*-Atyien), had been dedicated by quarrymen (*Λατυποί*), supports the existence of the quarries in the surroundings as epigraphic resource. The excavations we carried out in the district of Han, not far away from Başara (c.4.5 km) and the surveys we conducted in the region, present reliable evidence that the main production of the atelier/s which had carved the marble extracted from the quarries, were Door-steles. These detections in the case of Başara attract attention by revealing with reliable evidence that the intensive material necessity which was required for construction activities increasing parallel to the enlargement of the cities and rising population around Anatolia in Roman Imperial Period and other areas of social life like honour monuments, votive and grave steles, was not only provided from the large stone quarries such as Docimeion and Prokennesos but also from small scale local quarries in the rural settlements and the local ateliers working with this material.

THE STONE AND ANCIENT QUARRIES of the MONTJUïC MOUNTAIN (Barcelona, Spain)

Aureli ÁLVAREZ

Institut Català d'Arqueologia Classica (ICAC), Tarragona, Spain (aalvarez@icac.net)

Keywords: Montjuic Mountain, sandstone, Roman quarries, recent queries

Montjuïc Mountain is situated to the south of the city of Barcelona, surrounded by Quaternary deposits and next to the Barcelona graben. In the north and west it comes into contact with the Barcelona Plain. In the south it comes into contact with the Delta of the Llobregat River (Llopis Lladó 1942). On the sea side, it is cut off by a fault that runs parallel to the coastline.

The materials are dated as Serravallian Age (Late Miocene). The deposits are made up of alternating layers of conglomerates and sandstones, with lesser presence of mudstones.

The sandstone has a siliciclastic composition and can be considered a litharenite. The monocrystals of quartz predominate over polycrystalline aggregates, the fragments of rocks correspond to granitoids, granitic porphyries, quartzite, phyllites, schist, aplites, pegmatites and radiolarites. Associated minerals are biotite, muscovite, zircon, chlorite and tourmaline.

The first quarries on Montjuïc date back to Roman times (Gutiérrez 2009). This is the stone that was used to build Roman *Barcino* from its founding during the reign of Emperor Augustus. It was the material used to build the first city walls and it was also frequently used for sculptures and inscriptions.

The proximity to the city of Barcelona and its urban requirements led to the proliferation of quarries all over Montjuïc Mountain. Some were exploited and abandoned in ancient times and others in more recent times (Faura-Sans 1917; Alvarez 1988a,b; Alvarez, Mayer 1983).

In preparation for the 1992 Olympic Games, large faces in the Roman quarries facing the sea were excavated and studied (Granados 1991).

Montjuïc sandstone was used outside of the city of Barcino in other towns and settlements in the Laietania area, such as Iluro (modern-day Mataró).

MARMOR LAPISQVE, A NEW WEB DATABASE CATALOGUE. A REFERENCE OF HISPANIC STONE MATERIALS USED IN ANTIQUITY

Aureli ÀLVAREZ,[1] Anna DE MESA,[1,2]
Anna GUTIÉRREZ GARCIA-M.,[3] Pilar LAPUENTE,[4] Isabel RODÀ,[1,2]
Hernando ROYO PLUMED[1]

[1]Institut Català d'Arqueologia Clàssica (ICAC), Tarragona, Spain
(aalvarez@icac.net; hroyo@icac.cat)
[2]Department de Ciències de la Antiguitat i l'Edat Mitjana, Universitat Autònoma de Barcelona (UAB), Bellaterra, Spain (ademesa@icac.cat; iroda@icac.cat)
[3]Institut de Recherche sur les ArchéoMATériaux (IRAMAT) - Centre de Recherche en Physique Appliquée à l'Archéologie (CRP2A)Université de Bordeaux Montaigne, Bordeaux, France (anna.gutierrez@u-bordeaux-montaigne.fr)
[4]Universidad de Zaragoza (UNIZAR), Department Ciencias de la Tierra, Zaragoza, Spain
(plapuent@unizar.es)

Keywords: database, marmora, Hispania

MARMOR LAPISQVE is part of a well-established line of research recognized by the Ministry of Economy and Finance of the Spanish Government and part of several R+D Projects. This line started the 1970s, first at the Universitat Autònoma de Barcelona (UAB) and later on, at the Institut Català d'Arqueologia Clàssica (ICAC). The research team involved is a multidisciplinary (archaeology, archaeometry, geology) and multi-institutional (ICAC, UAB, UNIZAR, CNRS/Université de Bordeaux Montaigne) one. This collaboration has proved to be very successful. On the one hand, it has led to the consolidation of an archaeometric team dedicated to the analysis of characterization and historical-archaeological interpretation of materials (Unitat d'Estudis Arqueomètrics, (ICAC). On the other hand, the collaboration between different institutions has resulted in the gathering of an extensive reference collection of stone samples both at the LEMLA (Laboratory of Stone Materials in Antiquity) of the Autonomous University of Barcelona (UAB) and the Department of Geology of the University of Zaragoza (UNIZAR).

The MARMOR LAPISQVE Project, presented in this contribution, focuses on the creation of a web page with a database that has been generated for nearly two decades and which includes over 7000 sample records from

both archaeological objects and geological origin from the entire Mediterranean basin, with special application to the Hispanic stone materials used in Antiquity.
The design consists of two types of queries, by Quarry or by Stone Type, for easy reference data. Standardized forms provide a complete characterization of the quarry / type, analytical results, images, references and a list of related archaeological samples.
One of the main objectives of the catalog is to offer a common platform for different research teams, covering the gap between the research data and the results published. The data stored on this site will respond to an access system, with different access levels being defined by copyright clauses under current legislation. The analytical results will be restricted to the authors and will be accessible only after their permission.
This database is conceived as a quick and direct tool for the multi-institutional team mentioned above, but with projection for exchanging information between researchers from other institutions.
Furthermore, the website presents general public descriptions for each material, in order to provide the updated state about the study of the Roman Hispanic quarries and the provenance of archaeological stone materials.

INITIAL ARCHAEOMETRIC STUDIES OF THE MARMARITSA MARBLE QUARRY AT MARONEIA AND TWELVE THRACIAN FUNERARY RELIEFS IN THE KOMOTINI MUSEUM (GREECE)

Dimitra ANDRIANOU,[1] Lorenzo LAZZARINI[2]

[1]National Hellenic Research Foundation, Institute of Historical Research, Section of Greek and Roman Antiquity, Athens, Greece (dandr@eie.gr)
[2]Laboratorio di Analisi dei Materiali Antichi - Sistema dei Laboratori - Università IUAV di Venezia, Venice, Italy (lorenzo@iuav.it)

Keywords: Museum of Komotini, Thracian quarries and marbles, archaeometry

As part of a larger, synthetic study of the figural tombstones from Aegean Thrace, twelve funerary stelai were sampled in order to identify the provenance of their marble. The stelai date from the fifth century BC to the first century AD and depict iconography influenced by Attic and Ionian centers (standing and seated female figures, Heros Equitans and funerary banquets). The samples were characterized archaeometrically by mineropetrographic analyses (polarizing microscopy on thin sections and X-ray diffraction on powders) with the mass-spectrometric determination of the C & O stable-isotope ratio. Supposing that local marbles (as well as imported ones) could have been used for such stelai, the ancient marble quarries of Marmaritsa, situated on the SW slopes of Mount Ismaros, close to the archaeological site of Maroneia, were also sampled and analysed using the same method.

The results were then compared with those of the local marble and the most updated international database of the most productive-high quality marbles used in Greek and Roman Antiquity. Thus far, the results/research indicate that some of the funerary stelai employed dolomitic marbles from Pentele, Proconnesos and Thasos while the remainder used Thracian marbles from Marmaritsa and another source as of yet unidentified.

TTHE USE OF WHITE MARBLES IN ROMAN GORTYN (CRETE) AS RESULTING FROM ARCHAEOMETRIC ANALYSES

Fabrizio ANTONELLI,[1] Jacopo BONETTO,[2] Maria Giovanna FABRINI,[3] Lorenzo LAZZARINI1

[1]Laboratorio di Analisi dei Materiali Antichi – Sistema dei Laboratori – Università IUAV di Venezia, Venice, Italy (fabria@iuav.it; lorenzo@iuav.it)
[2]Dipartimento dei Beni Culturali, Università di Padova, Padova, Italy (jacopo.bonetto@unipd.it)
[3]Dipartimento di Studi umanistici, Università di Macerata, Macerata Italy, (giovanna.fabrini@unimc.it)

Keywords: Gortyn (Crete), white marbles, archaeometric analyses

Gortyn was an important Cretan town from the Late Archaic to the Hellenistic period, after which it became one of the provincial capitals of the Roman Empire. Situated in the centre of the island, one of the major crossroads of the Mediterranean Sea between the East and West, the town controlled the whole of Crete and Cyrenaica, flourishing in the first centuries of our era as a result of its commerce and agricultural products. It continued to be quite important in the proto-Byzantine period, but suffered from gradual depopulation from the 8th century onwards. The very large corresponding settlement (nearly 400 ha.) has been one of the main sites of Italian archaeological research in Greece since 1884 where several excavation campaigns have been carried out under the supervision of the Italian Archaeological School of Athens. In the last ten years, a specific research project, conducted by the University of Padua, has focused on the study of the small theatre near the Apollo Pythion sanctuary. Over the last hundred years and more, many portions of the Greek and Roman town have been unearthed and many stone artefacts found, many of which were made of imported marble. The island of Crete itself offered only a poor quality grey marble from Aghios Kyrillos, a place close to Gortyn: this marble was used solely for architectural elements. Marble statuary and other prestigious artefacts found in Gortyn were made of white marbles, several of which were sampled and subjected to archaeometric examinations (optical microscopy in thin section, powder X-ray diffraction, and mass-spectometry for the

determination of the C and O isotopic ratio) in order to identify their quarries of origin. The results obtained from the analysis of several tens of the white marble objects sampled have indicated the use of a wide variety of species including Parian, Pentelic, Thasian and Proconnesian marble; the first three, especially the Pentelic, largely prevailing for statuary, the fourth, for architectural elements.

THE LATE HELLENISTIC FUNERARY RELIEFS OF THE ARCHAEOLOGICAL MUSEUM OF NAPLES: HISTORICAL, ARTISTIC AND ARCHAEOMETRIC ASPECTS

Fabrizio ANTONELLI,[1] Fabio COLIVICCHI,[2]
Stefano CANCELLIERE,[1] Lorenzo LAZZARINI[1]

[1]Laboratorio di Analisi dei Materiali Antichi – Sistema dei Laboratori – Università IUAV di Venezia, Venice, Italy (fabria@iuav.it; stefanoc@iuav.it; lorenzo@iuav.it)
[2]Classics Department, Queen's University, Kingston, Ontario, Canada (colivicf@queensu.ca)

Keywords: Hellenistic stelae, National Archaeological Museum of Naples, white marble, provenance

Seven Hellenistic stelae with Greek inscriptions found in various excavations of the ancient city of Naples were minero-petrographically (by optical microscopy on thin section and XRD on powder) and geochemically (by stable isotopes ratio analysis) examined in order to determine the provenance of the constituent marbles. According to epigraphic characteristics, all stelae date back to the 1st century BC and the early Imperial age, subsequent to the well-known Hellenistic stele of Ancona. Archaeologists in fact often relate the latter to the Neapolitan stelae and to Greek Delian workshops. The results of the laboratory analyses demonstrate the use of Parian marbles (from Lakkoi and Stephani) only for three stelae, whereas the Lunense marble from Carrara was employed for the remaining four reliefs. The research outcomes suggest a local workmanship of small imported blocks of Aegean and Apuan marbles. The use of Hellenistic type reliefs concerns a more general response of the community of Naples to the new status of Roman *municipium* as part of a cultural strategy to emerge as an "authentic" Greek city. Emphasizing its Hellenic origin, both at the private/funeral and institutional/public level, the city of Naples was able to stand out with respect to other Campanian centers and to promote itself in relation to Rome.

METHODS OF CONSOLIDATION AND PROTECTION OF PENTELIC MARBLE

Maria APOSTOLOPOULOU,[1] Elissavet DRAKOPOULOU,[2]
Maria KAROGLOU,[1] Asterios BAKOLAS[1]

[1]Department Materials Science and Engineering, School of Chemical Engineering,
National Technical University of Athens, Athens, Greece
(mairi_apostol@central.ntua.gr; margo@central.ntua.gr; abakolas@mail.ntua.gr)
[2]Acropolis Restoration Service, Athens, Greece (elsa@amallou.net)

Keywords: Consolidation materials, marble decay, intergranular corrosion, protection of monuments, assessment of marble consolidation

The purpose of this research study was to investigate the performance of the consolidating and protective effect of treatments carried out on Pentelic marble specimens. Consolidation materials and techniques were applied and evaluated on samples of Pentelic marble, deriving from two different restoration periods of the Propylaea restoration in the Acropolis of Athens; the interventions carried out by Nicolaos Balanos in the early 20th century (1909-1917) and the other by Anastasios Orlandos in the middle of the 20th (1947-1957).

An alcohol-based nanodispersion of calcium hydroxide and a suspension of traditional lime were used as consolidants, with and without the addition of sodium stearate, in order to assess its additional water-repellent ability. The selection of these materials was made in order to compare the traditional materials that are used still in practice (suspension of traditional lime), with new consolidation materials, such as nanodispersion of calcium hydroxide.

Before consolidation, the specimens were examined in order to assess their state of conservation. During the diagnostic process of the subordinate condition of the marble samples, a portable digital microscope, infrared spectroscopy with Fourier transformation, as well as colorimetric tests were applied. The main type of decay was the marble surface sugaring.

Throughout the evaluation phase, the water static contact angle measurement was applied, for the examination of the achieved hydrophobicity. Ultrasonic treatment of the consolidated specimens was also carried out, in order to study the adhesion degree with the substrate.

The results showed that the nanodispersion of calcium hydroxide with the addition of 90 mg/l sodium stearate exhibited the optimal surface consolidation results, while at the same time achieving a good degree of hydrophobicity. It can therefore be applied, for both consolidation and protection treatments of Pentelic marble.

GIALLO ANTICO IN CONTEXT. NEW STRATIGRAPHIC DATA FROM THE WESTERN MEDITERRANEAN (2nd c. BC-1st c. AD)

Stefan ARDELEANU

Humboldt University of Berlin/German Archaeological Institute Berlin, Berlin, Germany (st.ardeleanu@gmail.com)

Keywords: Marmor Numidicum, Simitthus, stratigraphical contexts

Giallo antico was one of the most famous and widespread coloured marbles used in Antiquity. The marble was extracted in Simitthus (nowadays Chimtou, in NW Tunisia), where a joint Tuniso-German team has been doing fieldwork from the 1960s onwards. Although previous scientific investigation has led to important results concerning extraction techniques and marble workshops as well as administration and properties in the quarries of the High Imperial time, many questions still remain open for debate. A serious lack of knowledge concerns the early phases of the extraction activity, the marble's trading and transport routes, but also actors involved in the commercialization of the stone. This fragmentary picture corresponds neither to the evidence at Simitthus, nor to the huge quantities of *marmor Numidicum* that appear in overseas-areas not later than in the 2nd half of the 1st c. BC.

Therefore, this paper seeks to discuss some new contexts of *giallo antico* use with reliable chronological evidence from the 2nd c. BC to the end of the 1st c. AD. During the last two decades, excavations in the Western Mediterranean such as Italy, France and Spain provided a steadily increasing amount of such data. These records urgently require a comparative analysis that integrates new evidence from North Africa. Basing on recent excavation work in various spots of the civic town in Simitthus, in which I have been involved from 2009 onwards, this paper will critically discuss the prevailing views that the marble was not used in its "home town" and was almost entirely absent in early North African townscapes.

The main goal is to ask if a closer look at the marble's early distribution and at its precise use and function in early contexts could provide a better understanding of trading routes, of economic organization and of special

commercial demands. The high variability in the shape of *giallo antico*-objects from such stratigraphic contexts challenges the *opinio communis* of an exclusively Imperial control of the quarries in Simitthus and leads to new questions about marble workshop activity at a very early date. Furthermore, a new survey of early epigraphic data from Simitthus and elsewhere, as well as a broader link of the marble trade to other commercial objects/routes from and to North Africa could allow us to name some new actors involved in this commerce.

ANCIENT QUARRIES AT KURŞUNLU IN LYCAONIA (TURKEY)

Aytuğ ARSLAN

Faculty of Tourism, İzmir Katip Çelebi University, İzmir, Turkey (aytug.arslan@ikc.edu.tr)

Keyword: Lycaonia, Iconium, Roman Quarries, Kurşunlu

The ancient quarries have been discovered at the Village of Kurşunlu, which is 40 km northwest of Konya, in the course of the surveys carried out recently in Lycaonia Region. It is understood that the quarries of which traces extend over a large area on rocky slopes in the south and west of the settlement had been exploited during Roman and Byzantine Periods. In one of these areas, a female figure carved on bedrock, a border inscription accompanying it and altar pit related to libation, attract great attention in terms of indicating that the quarries had been used since Roman Imperial Age and a ritual of libation had been performed in the quarry area.

The grave steles belonging to the Early Byzantine Period, the structural and liturgical elements dating back to the Middle Byzantine Period were discovered during our surveys as well as many inscriptions and grave steles which had been found before at the epigraphic surveys carried out by W.M. Ramsay and W.M. Calder in Sarayönü, Bahçesaray and Lâdik. Lâdik is localized as the ancient city of Laodicea Katakekaumene (Combusta) in the vicinity of Kurşunlu where the quarries are located. It seems that the stone necessity which was required in Lâdik and its surroundings was largely provided from these quarries.

THE LOCAL QUARRIES OF THE ANCIENT ROMAN CITY OF *VALERIA* (CUENCA, SPAIN)

Javier ATIENZA FUENTE

Universidad Nacional de Educación a Distancia (UNED), Madrid, Spain
(arqueosofia@gmail.com)

Keywords: Roman quarry, methods of exploitation, extraction front

The ancient Roman city of *Valeria* had in its immediate surroundings, abundant quality stone material with which to conduct its architectural projects. Near the town site is a large stone extractive sector in which, despite the elapsed time and the transformations undergone, more than a dozen extractive fronts in different degrees of conservation have been located.

Unfortunately, the quarries of *Valeria* have not attracted the interest of the scientific community and have not been subject to any detailed investigation to date.

The objectives for conducting this research were: to try to know, based on the distribution of localized quarry fronts, the extent of the quarrying area; to determine whether the process of exploitation was the same for all fronts or if there was evidence of the use of different methods, and finally, to try to specify the type of product obtained after the extractive exploitation of the fronts.

In order to reach the objectives, a visual prospection was conducted in the field that allowed delimiting an area within which extraction fronts are located. To determine the exploitation system used in each of the fronts extractive, the types of traces left on the rock surface were analyzed, as well as its shapes and directions. In only one of the extractive fronts, were localized several blocks abandoned in different phases of the extracting process, but still attached to the rock surface. This circumstance allowed accurate identification of the exploitation procedure used. The blocks abandoned in the extraction front, and the location in the vicinity of the quarry area of other stone elements in an apparent state of semi-processing, suggest some productive diversity.

The conclusions following this preliminary study seem to indicate the existence of a large area of stone extraction in which multiple fronts were

opened and where intense mining activity was present. The exploitation procedure used in *Valeria* consisted in opening an extraction front by horizontal tiers that covered the entire length of the front and exploited vertically. The depletion of extractive fronts exploited by this method resulted in vertical walls completely covered by marks left by the tools that have intervened in the extractive process, which is observed in most cases. The visual exploration and the surface data collection do not allow definitive conclusions. However, there are other issues such as the starting date of extractive activity or the dating, that, because of its abandonment, remain in the field of hypotheses for which only an archaeological intervention could provide definitive data.

THE MARBLE OF ROMAN IMPERIAL PORTRAITS

Donato ATTANASIO,[1] Matthias BRUNO,[2] Walter PROCHASKA,[3]
Ali Bahadir YAVUZ[4]

[1]Istituto di Struttura della Materia, Consiglio Nazionale delle Ricerche (ISM-CNR), Rome, Italy (donato.attanasio@ism.cnr.it)
[2]Via dei Vascellari 34, Rome, Italy (matthiasbruno@libero.it)
[3]Department of Applied Geosciences and Geophysics, University of Leoben, Leoben, Austria (walter.prochaska@unileoben.ac.at)
[4]D.E.Ü Engineering Faculty, Geological Engineering Department, Izmir, Turkey (bahadir.yavuz@deu.edu.tr)

Keywords: Imperial portraits, Marble provenance, Trace analysis, EPR, isotopes

One hundred fifty seven Roman Imperial portraits were investigated using isotopic, trace elements, EPR and grain size analyses with the aim of obtaining quantitative data on the use of sculptural marble. Imperial portraits, mostly coming from Rome, were selected for being top quality sculptural productions of known chronology that may provide important diachronic information. The selection spans approximately 500 years: from the mid 1st century BC (portraits of Caesar were analyzed) to the end of the 4th or beginning of the 5th century AD, because a portrait identified as Valens or perhaps Honorius was tested. Additional archaeometric work, presented elsewhere, was carried out to improve discrimination and especially to obtain unequivocal separation between Carrara and Göktepe. Twelve different marbles were identified, but most of the portraits were made using only four different varieties that are, in order of frequency, Göktepe, Parian *lychnites*, Carrara, and Docimium. Approximately half of the portraits (48%) were found to be Göktepe with Parian *lychnites* following at great distance (21%). The distribution frequency is strongly time dependent. Until the end of the 1st century AD the marble of choice was *lychnites,* used for 78% of the analyzed Julio-Claudian portraits. A sudden change, however, happened in Hadrian's time when the use of *lychnites* sharply reduced to 10-15% and was replaced by Göktepe (60%) that became the statuary marble *par excellence*, a trend that continued and grew further in later times. The portraits of Caracalla provide a particularly striking example of this tendency. Ten portraits of this emperor were tested: nine of them turned out to be Göktepe, whereas the last one is marble of the Aphrodisias city quarries.

Within this picture, the marble of Carrara plays a rather minor role. This is the first large scale quantitative study on the use of sculptural marbles and leads to the clear conclusion that, during Imperial times, Göktepe became the most important and widespread marble used for top quality sculpture. Apparently its use, introduced by Aphrodisian sculptors, rapidly extended to most metropolitan ateliers. The significance of this phenomenon in determining the stylistic and technical peculiarities of urban production will be briefly considered.

AN EARLY BYZANTINE SARCOPHAGUS OF CALCITIC MARBLE FROM THASOS IN SIRACUSA, SICILY

Donato ATTANASIO,[1] John J. HERRMANN,[2]
Annewies VAN DEN HOEK[3]

[1]Istituto di Struttura della Materia, Consiglio Nazionale delle Ricerche (ISM-CNR), Rome, Italy (donato.attanasio@ism.cnr.it)
[2]Museum of Fine Arts, Boston, Dedham, Massachusetts, United States (jherrmannjr@gmail.com)
[3]Harvard Divinity School, Cambridge, Massachusetts, United States (ahoek@hds.harvard.edu)

Keywords: Byzantine sarcophagus, Marble provenance, Thasos calcite

A Christian sarcophagus in the Galleria Regionale Palazzo Bellomo in Siracusa is made of a grayish marble with very large grain that appears macroscopically to be the calcitic marble of the northern Greek island of Thasos. Two samples were taken and analyzed with paramagnetic resonance spectroscopy (EPR), and isotopic analysis. The maximum grain size (MGS) and color were quantified. The analyses confirmed that the sarcophagus was, in fact, made of marble from the quarries of Aliki on Thasos. This identification is notable since calcitic marble from Thasos is relatively rare in sarcophagi in Italy. Furthermore, this sarcophagus is remarkably late. On the front and on the back it is decorated with three simple crosses on steps. On the front, discs appear between the crosses. In Byzantine coinage, stepped crosses were popular from the late 6th into the 8th century. It is within this span that the carving should be dated. The sarcophagus has been dated to the 9th or 10th century, which seems too late, since more elaborate forms of cross were popular on coinage of that time. The chest does not appear to be reused; close inspection revealed no trace of earlier carving. The decoration could have taken place on Thasos since the rough workmanship of the crosses is typical of late production on the island. The sarcophagus thus provides striking evidence not only of quarrying but also of long-distance trade in Thasian marble in post-Justinianic times (i.e. after 565). An 8th century date can probably be excluded since trade between the eastern and western Mediterranean seems to have been drastically curtailed at that time.

NEW INVESTIGATIONS ON THE FRAGMENTS OF WHITE MARBLE STATUES IN THE MUSEUM OF DELPHI

Hélène AURIGNY,[1] Philippe BLANC,[2] Annie BLANC,[3]
Danièle BRAUNSTEIN,[4] Jean-Luc MARTINEZ[4]

[1]Centre Camille Jullian, Aix-en-Provence, France (aurigny@mmhs.univ-aix.fr)
[2]Sorbonne Universités UPMC, Paris, France (philippe.blanc@upmc.fr)
[3]Sorbonne Universités LAMOP, Paris, France (philippe.blanc64@sfr.fr)
[4]Musée du Louvre, Paris, France (Daniele.Braunstein@louvre.fr;
Jean-Luc.Martinez@louvre.fr)

Keywords: white marble, Greek sculpture, non-destructive investigation

During the summer of 2013 a small team of the Louvre Museum, the Ecole Française d'Athènes and the Centre Camille Jullian, intended to characterize a series of ancient sculptures housed in the Archeological Museum of Delphi. Before asking for permission to analyze samples of marble, we wanted to make an evaluation based on direct and systematic observation of the marbles. The question we had to solve was how to observe white marble without sample, in the Museum and its depots.

A paper from O. Palagia and N. Herz (ASMOSIA, 2002) had given results of stable isotopic ratio analyses of 21 samples of marble sculptures of the Museum. We used this work as a basis to continue the investigations. The identification of the marble rests on different criteria: color, grain size (two difficult targets with the patina), translucence, presence of accessory minerals, typical odor of sulfur after a light choking (the Parian marble can smell) and weathering alterations.

In the Museum, visual examination of the sculptures is very limited, however, fine-grained marble containing small veins of mica can be separated from medium-grained Parian marble. This mineralogical examination on the sculptures of the Daochus Monument shows that two different marbles were used: Pentelic marble for the statues with drapery and Parian marble for the nude bodies.

For the 139 elements observed in the storerooms, examinations were easier and we may separate Pentelic marble and two varieties of Parian marble. This study shows that with a corpus of numerous marble elements, without extracted samples, it is possible to indicate a provenance, with a limited probability. In numerous cases, a very small chip of marble will be necessary to confirm, with isotopic analysis, the marble identification.

TWO IMPERIAL MONUMENTS IN PUTEOLI: USE OF PROCONNESIAN MARBLE IN THE DOMITIANIC AND TRAJANIC PERIODS IN CAMPANIA

Irene BALD ROMANO,[1] Hans RUPPRECHT GOETTE,[2]
Donato ATTANASIO,[3] Walter PROCHASKA[4]

[1]School of Anthropology, University of Arizona, Tucson, Arizona, United States (ireneromano@email.arizona.edu)
[2]Deutsches Archäologisches Institut, Berlin, Germany (Hans.Goette@dainst.de)
[3]Istituto di Struttura della Materia, Consiglio Nazionale delle Ricerche (ISM-CNR), Rome, Italy (donato.attanasio@ism.cnr.it)
[4]Department of Applied Geological Sciences and Geophysics, University of Leoben, Leoben, Austria (walter.prochaska@unileoben.ac.at)

Keywords: Proconnesian, marble, Domitian, Puteoli

A marble panel in the collections of the University of Pennsylvania Museum of Archaeology and Anthropology ("Penn Museum") in Philadelphia (MS 4916; H. 1.62 m), discovered in Puteoli on the Bay of Naples in 1908 and acquired by the museum in 1909, bears an inscription lauding the emperor Domitian for his good public works benefitting Puteoli. The inscription can be closely dated by historical information, including the death and *damnatio memoriae* of Domitian, and by imperial titles from September AD 95 to September AD 96. It was probably part of a large base for an equestrian statue of the emperor. Stable isotopes, EPR, and petrographic analyses have determined that the marble is from the Proconnesian quarries. Although Proconnesian marble was used for some major 4th c. BC and Hellenistic monuments in Asia Minor (e.g., Mausoleum of Halicarnassos and Altar of Pergamon), Roman exploitation of the quarries of Marmara began with more regularity in the Flavian period, gradually replacing Luna marble in the 2nd c. AD as the most prevalent white marble for architectural monuments in the Italic peninsula and elsewhere. This precisely-dated inscription from Campanian Puteoli is an important example of an imperial (i.e., constructed by imperial order) monument of Proconnesian marble and establishes another fixed point in the late Flavian period for the use of this marble.

The Penn Museum's marble panel had another life after Domitian's assassination and disgrace. The inscription was "erased," using a chisel to care-

fully pick out the eleven lines, though it is still legible with a raking light. The block was reused in another imperial monument in Puteoli, this one of the Trajanic period and dated by style to ca. AD 102. The opposite face was carved in relief with soldiers including members of the emperor's elite Praetorian Guard. The Penn Museum panel joins at right angles with another marble relief panel with a single soldier, now in the Neues Museum in Berlin (Sk 887; H. 1.59 m), discovered in Puteoli in 1801 and acquired by the Antikensammlung in 1830. Other possible sculptural fragments of this rather enigmatic large imperial monument (arch or altar enclosure or base?) have been identified among the Puteoli finds in the Museo Archeologico dei Campi Flegrei in Baia, but no architectural traces have been found. In this paper we compare the marble of the panels in Philadelphia and Berlin and suggest a methodology for identifying other parts of the Trajanic monument in order to approach a reconstruction.

CALCITIC MARBLE FROM THASOS IN NEA ANCHIALOS (MAGNESIA, CENTRAL GREECE) AND THESSALONIKI

Vincent BARBIN,[1] John J. HERRMANN,[2] Aristotle MENTZOS,[3] Annewies VAN DEN HOEK[4]

[1]Université de Reims Champagne-Ardenne; Centre de Recherches-Agronomique, Reims, France (vincent.barbin@univ-reims.fr)
[2]Museum of Fine Arts, Boston, Dedham, Massachusetts, United States (jherrmannjr@gmail.com)
[3]Department of History and Archaeology, University of Thessaloniki, Thessaloniki, Greece (mentzos@hist.auth.gr)
[4]Harvard Divinity School, Cambridge, Massachusetts, United States (ahoek@hds.harvard.edu)

Keywords: Thasian marble, Proconnesian marble, Early Byzantine architectural ornament, cathodoluminescence microscopy, stable isotopes of carbon and oxygen

Thirteen pieces of architectural ornament were analyzed to scientifically explore the use of Proconnesian and northern Greek marble in Nea Anchialos (Phthiotic Thebes), a central Greek city with many splendid churches and much high-quality Early Byzantine architectural decoration. Small chip samples were taken from Ionic impost capitals and from panels and colonnettes of chancel barriers, which range in date from the fifth to the seventh centuries. The samples were studied with cathodoluminescence, and their ratios of stable isotopes of carbon and oxygen were determined. The analyses identified marble from Proconnesus and calcitic marble from Thasos.

Stylistic and typological similarities show that most pieces in our survey were carved by sophisticated workshops closely connected with Constantinople, and that these workshops used marbles both from the Constantinople area (Proconnesian) and from northern Greece (Thasian). The use of Thasian marble by the Constantinople-affiliated workshops showed that pieces were carved in Greece and probably at Nea Anchialos itself. Some pieces in Proconnesian marble might have been sent from the quarries or from Constantinople in a finished state. A few of the sculptures in Thasian marble show unusual features that reveal the role of local Greek sculptors. Two entablatures from Thessaloniki also proved to be Thasian calcitic marble. One of them, which dates from the third century, was in a completely

Asiatic style. The other, of the fourth or fifth century, was distinctly local. A block from a pier of the Octagon of Philippi was also sampled. This piece proved to be marble from the local quarries of Philippi.

THE MARBLE TRADE AT POMPEII AND HERCULANEUM

Simon J. BARKER

Department of History, Classics and Archaeology, Birkbeck, University of London, London, United Kingdom (simon.barker3@gmail.com)

Keywords: marble, houses, Campania

The popularity of stone decoration was not static and could be subject to change, with different varieties going in and out of fashion. This poster examines the decorative tastes for stone at Pompeii and Herculaneum during the years preceding the eruption of AD 79. It seeks to examine the selection of specific varieties of stone and their position within individual mosaic and *sectilia pavimenta*.

This study reveals preliminary results regarding ancient tastes towards marble during the first century AD on the Bay of Naples. One trend in marble use that is evident in Campania is a preference for the display of new varieties of stone. This is reflected in *sectila pavimenta*, which make use of multiple varieties of stone in the same composition. As a consequence of the increased availability of "new" marble types, pavements excluded popular Republican stones like *palombino*, *paesina*, *ardesia,* other Italian materials, as well as white marble, which appears to have been viewed as old fashion or outdated during this period.

This poster will address how these "new" varieties fit alongside the more typical "metropolitan" varieties, which remained in favour within Pompeii and Herculaneum. How, for example, should we view the prominent use of *breccia corallina* at Villa A, Oplontis? Did the owners use this stone because they were not able to secure the top-shelf "imperial" varieties? Should we consider marbles *like breccia corallina* as poor substitutes – the so-called *marmi sostituivi* - or as examples of local trends running parallel or even diverging from "metropolitan" ones? While the tried and tested marbles like *pavonazzetto*, *giallo antico*, *africano* are perhaps still at the top of elite tastes, this poster concludes that a second important trend for displaying new varieties was prevalent at Pompeii and Herculaneum during the period prior to AD 79.

THE STONE DÉCOR AT THE VILLA ARIANNA AND VILLA SAN MARCO (CASTELLAMMARE DI STABIAE)

Simon J. BARKER,[1] J. CLAYTON FANT[2]

[1]Department of History, Classics and Archaeology, Birkbeck, University of London, London, United Kingdom (simon.barker3@gmail.com)
[2]Department of Classical Studies, Anthropology and Archaeology, University of Akron, Akron, Ohio, United States (cfant@uakron.edu)

Keywords: marble, Villa Arianna, Villa San Marco

Campanian houses are justly famous for their decorative wall-painting, however the equally exceptional stone décor has not received due attention. The 'Marmo al Mare Project' presents preliminary results in its ongoing campaign to make the first comprehensive study of the lithic decoration for the most prominent elite houses within the Vesuvian area (work on Villa A at Oplontis was presented at the Xth Amosia meeting in Rome).

This paper presents the initial results of two seasons of survey work at the Villa Arianna and Villa San Marco at Ancient Stabiae (modern Castellammare di Stabia). The paper discusses several results of this project: first, a survey of the overall marble-use at the Villa Arianna (and the so-called Secondo Complesso) and the Villa San Marco, including but not limited to marble thresholds, pavements and wall revetment. Our study of San Marco confirms that the marble pavement in Room 10 employed rare Egyptian granites, including Granito della Colonna (Wadi Umm Shegilat) and Sedia di S Lorenzo (Wadi Semna) and that Room 16 had the largest marble floor of any residence in the Vesuvian area with a wall-to-wall *opus sectile* pavement of over 200 m^2. Secondly, this paper discusses the level of marble décor at both villas, the range of stones represented at each site, their qualities and quantities, and how the villas compare to other houses within the wider Vesuvian area in the use of marble in domestic décor. Finally, our approach to the quantification of marble varieties and prestige levels is discussed, including new methods of recording and analysing mosaic pavements with marble inserts. In total three such pavements are known at the Villa Arianna in Rooms 3, 31-35-41 and M (no such pavements are attested at San Marco). The pavements in Rooms 3 and M were examined in detail as a test case for our methodology and its scope for examining similar pavements at Pompeii and Herculaneum are also discussed.

ARCHAEOMETRIC ANALYSIS OF WHITE MARBLES FROM VILLA ARIANNA (CASTELLAMMARE DI STABIAE, ITALY)

Simon J. BARKER,[1] J. CLAYTON FANT,[2] Lorenzo LAZZARINI[3]

[1]Department of History, Classics and Archaeology, Birkbeck, University of London, London, United Kingdom (simon.barker3@gmail.com)
[2]Department of Classical Studies, Anthropology and Archaeology, University of Akron, Akron, Ohio, United States (cfant@uakron.edu)
[3]Laboratorio di Analisi dei Materiali Antichi - Sistema dei Laboratori - Università IUAV di Venezia, Venice, Italy (lorenzo@iuav.it)

Keywords: White marble, provenance, archaeometry, Villa Arianna, Stabiae

The poster presents the results of a minero-petrographic and isotopic study – minero-petrographical (by XRD and OM on thin section) and geochemical (isotopes analysis by mass spectrometry, and chemical quantitative analysis by XRF) conducted by LAMA (Laboratorio di Analisi dei Materiali Antichi) – carried out on white architectural marbles at the Villa Arianna (modern Castellammare di Stabiae). In total six samples were taken from a number of rooms in the villa: the socle of the wall revetment in room 24 (three samples), the socle from the doorway between room 31 and room 06 in the thermal complex (1 sample), the windowsill in Room P located at the NE corner of the large garden peristyle (1 sample), and the *opus sectile* of room R (1 sample).

Visual analysis indicates the prevailing presence of marmor Lunense. Analytical data indicate the use of stone classified as a micro-fossiliferous sparmicrite for the *opus sectile* floor of room R. Its macroscopic and microscopic aspect are quite similar to that of *palombino bianco*, a limestone quarried in several localities of the Central Appenines (Italy), largely used in Roman *opera sectilia* from the Late Republic onwards. In addition, the marble for the revetment in atrium 24, the windowsill of room P at the NE garden peristyle and the revetment in the thermal quarter of Villa Arianna (Rooms 6 and 31) were found to be dolomitic marble coming from the Vathy quarries on the island of Thasos, Greece. Overall, our intention is to improve the knowledge of the employment of non-Italian varieties of white marble in elite décor of luxury villas by identifying the quarry origin of white marbles employed.

'ALABASTER': QUARRYING AND TRADE IN THE ROMAN WORLD. EVIDENCE FROM POMPEII AND HERCULANEUM

Simon J. BARKER,[1] Simona PERNA[2]

[1]Department of History, Classics and Archaeology, Birkbeck, University of London, London, United Kingdom (simon.barker3@gmail.com)
[2]Department of Classics, Royal Holloway, University of London, London, United Kingdom (simona.perna8@gmail.com)

Keywords: 'Alabaster', Pompeii, Herculaneum

'Alabaster', geologically labeled onyx marble, calcitic alabaster or travertine, was highly valued during the Roman period for ornamental uses. However the trade of this stone is not yet fully understood, with much more work needing to be done in terms of origin, quarries, use and distribution. Papers presented at previous ASMOSIA meetings (Barbieri *et al.*, Bruno, Çolak and Lazzarini at ASMOSIA VI-2000; Lazzarini *et al.*, Herrmann Jr. *et al.*, Scardozzi at AMOSIA IX-2009) have begun to address neglected aspects such as the archaeometric characteristics of 'alabaster' and the identification of ancient quarries. In order to profit from our increasing knowledge we also need to pay more attention to *in situ* examples.

The first season of the '*Alabaster:' Quarrying and Trade in the Roman World* Project has examined the *in situ* 'alabaster' at Pompeii and Herculaneum in order to determine the types employed at each city and changes in use from the second century BC to the first century AD. This has included a survey of various styles of pavement that employ inserts or tiles of 'alabaster', such as cement (*cioccopesto*), mosaic and *opus sectile*. In 2014 we were able to examine 14 out of 22 houses at Pompeii and 10 out of 12 houses at Herculaneum that employ 'alabaster', real or painted. The results of our survey show a varied use of 'alabaster' such as onyx and banded calcareous alabaster from Egypt, *fiorito* from Asia Minor, *Palombara* and *tartaruga* (possibly) from Italy and/or Asia Minor, and *alabastro a pecorella* from Algeria. An increasing use of the latter varieties, particularly of *pecorella* 'alabaster', is recorded at Herculaneum (House of the Alcove, House of the Telephus Relief) in Fourth Style floors (Guidobaldi *et al.*2014*)*, but no painted representations have been retrieved. Conversely, the Egyptian onyx/cotognino and

banded varieties of alabaster are overrepresented at Pompeii (e.g. House of the Menander) as inserts predominantly in Second and Third Style floors. These two varieties are also widely reproduced in the Second Style frescoes at Pompeii (House of the Labyrinth). However, certain painted types can be arguably identified as non-Egyptian *fiorito* or *tartaruga* 'alabasters' (e.g. Villa of Mysteries) which are also in use, albeit sporadically, in Third to Fourth Style floors (House of Fronto). Preliminary research shows that both at Pompeii and Herculaneum the "prestigious" varieties are used in prominent rooms/positions, while only in one case real and painted 'alabaster' are both employed in the same house at Pompeii.

The paper discusses the results of the survey at Pompeii and Herculaneum undertaken by our project whose future agenda also includes laboratory testing of selected 'alabaster' samples. By building a database of known datable examples and sources we can begin to greatly strengthen our knowledge of the quarrying, distribution, use and importance of 'alabaster' in the Roman world.

ARCHAEOMETRIC ANALYSIS OF THE 'ALABASTER' THRESHOLDS OF VILLA A, OPLONTIS

Simon J. BARKER,[1] Simona PERNA,[2] J. CLAYTON FANT,[3] Lorenzo LAZZARINI,[4] Igor M. VILLA[5]

[1]Department of History, Classics and Archaeology, Birkbeck, University of London, London, United Kingdom (simon.barker3@gmail.com)
[2]Department of Classics, Royal Holloway, University of London, London, United Kingdom (simona.perna8@gmail.com)
[3]Department of Classical Studies, Anthropology and Archaeology, University of Akron, Akron, Ohio, United States (cfant@uakron.edu)
[4]Laboratorio di Analisi dei Materiali Antichi - Sistema dei Laboratori - Università IUAV di Venezia, Venice, Italy (lorenzo@iuav.it)
[5]Institut für Geologie, Bern, Switzerland; Centro Universitario Datazioni e Archeometria, Università di Milano Bicocca, Milan, Italy (igor.villa@geo.unibe.ch)

Keywords: Ancient calcareous alabasters, Archaeometry, Villa A, Oplontis

A total of 13 thresholds composed of one or more blocks of 'alabaster' survive *in situ* at Villa A at Oplontis. They decorate the elegantly Second-Style painted rooms, such as atrium (5), *triclinium* (14), salone (15) and *cubiculum* (11), as well as (surprisingly) some service areas. The thresholds, which belong to Villa A's original phase of construction in the middle of the first century BC, arguably represent the most spectacular example of 'alabaster' use to survive from the villas and houses preserved by the eruption on Mt. Vesuvius in AD 79. Visual characteristics – dark beige to light gray with wavy patches and no banding, coarse to very coarse compact crystalline calcite - suggest that the source of the 'alabaster' could be either in Italy (close visual characteristics are with the 'alabasters' from Iano di Montaione, being most likely, or Quercetoin Tuscany; Camerino or Iesi in the Marche region; Collepardoin Latium) or Egypt (W.Samnur, El-Qawatir? Fayum's varieties of alabasterine gypsum?). Due to the difficulty of positive identification via visual analysis a total 7 samples from 6 thresholds have been subjected to analysis with the aim of determining the source of the stone; but we also seek to determine if more than one variety had been put together to compose the thresholds, particularly in the case of the thresholds of rooms 13/14 and 23/24.

The poster presents the results of a minero-petrographic and isotopic study – minero-petrographical (by XRD and OM on thin section) and geochemical (Sr isotopes by mass spectrometry, and chemical quantitative analysis by XRF) conducted by LAMA (Laboratorio di Analisi dei Materiali Antichi) and the Institut für Geologie at the Universität Bern – carried out on the 'alabaster' thresholds of Villa A, Oplontis. Sr isotope analyses are under way; their comparison with the Castelnuovo quarry ($^{87}Sr/^{86}Sr = 0.70798 \pm 0.00003$) and the Thyatira quarry ($^{87}Sr/^{86}Sr = 0.7081\text{-}0.7091$) will be presented. The results should provide further data regarding the potential sources and uses of this ornamental stone during Antiquity.

THE ROMAN SHIP 'PUNTA SCIFO D' AND ITS MARBLE CARGO (CROTONE, ITALY)

Carlo BELTRAME,[1] Lorenzo LAZZARINI,[2] Simone PARIZZI[3]

[1]Università Ca' Foscari Venezia, Venice, Italy (beltrame@unive.it)
[2]Laboratorio di Analisi dei Materiali Antichi - Sistema dei Laboratori - Università IUAV di Venezia, Venice, Italy (lorenzo@iuav.it)
[3]La Spezia, Italy (parizzi.simone@email.it)

Keyword: Roman, shipwreck, 3D

The Punta Scifo D shipwreck was discovered in 1986 in the Bay of Scifo, south of Crotone, Italy. Investigations in 2011 and 2013 included a 3-D documentation of the cargo, a sampling of the marble blocks, and the study of the pottery recovered in 1987. Studies of the cargo, using software for naval engineering calculations, were the basis for the virtual reconstruction of a barge about 40 m long and a 14 m beam. The study indicated a cargo of almost 340 tons. The only piece of wood was interpreted as a fragment of wale which showed a double row of mortise-and-tenon joints. The ship was dated to the 3rd century A.D. Petrographic and isotopic analyses demonstrated that it carried three different types of marble: mainly Proconnesian, some Pentelic, and at least one large slab of Docimean marble. The ship probably left from the island of Marmara, and stopped at Ephesus, and perhaps also at Piraeus.

AN ARCHAEOMETRIC STUDY OF PARIAN MARBLE ARTEFACTS IMPORTED TO THE ADRIATIC ETRUSCAN SITES OF SPINA AND MARZABOTTO

Fede BERTI,[1] Lorenzo LAZZARINI[2]

[1]Via Bugaro 6, Ferrara, Italy (fede.berti@alice.it)
[2]Laboratorio di Analisi dei Materiali Antichi - Sistema dei Laboratori - Università IUAV di Venezia, Venice, Italy (lorenzo@iuav.it)

Keywords: Spina-Marzabotto, Parian marble artefacts, archaeometry

Little archaeometric investigation has been carried out so far on the import and use of marble by the Etruscans, either in Etruria itself or in its central and eastern settlements. In the past, some laboratory analyses were performed on artefacts excavated in the latter, but the unsatisfactory results obtained explain why the previously analyzed pieces have now been re-examined with more reliable analytical methods. The present work also examined a number of artefacts that had hitherto not been investigated. The marble artefacts considered are a small head of a votive *kouros* from Marzabotto (province of Bologna) dating to the end of the 6th c. BC, plus a pair of cinerary urns, three funerary marks (two of which were obtained from anchors), a disc and three *pyxides*, all discovered in the necropolis of Spina (province of Ferrara) and dating to the 5th c. BC. The latter are particularly important since they are quite rare examples of precious objects seldom found outside Greece. Some of them were found in Cyprus and Southern Italy in association with Attic pottery, leading to the assumption that such artefacts, before reaching their final destination, passed through Piraeus where locally produced pottery was added: this was probably the case for the items from Spina. Given their rarity and value, very small samples were taken from each artefact: the relatively small samples were only subjected to a detailed macroscopic examination, to X-Ray diffraction and isotopic analysis by mass-spectrometry, while the larger ones were also examined minero-petrographically on thin section under a polarizing microscope. The results obtained indicate that all artefacts are made of Parian marbles: the *kouros*' head, the funerary urns and marks originate from the open-pit quarries of Lakkoi, while the pyxides, like a similar piece from Metapontum, were obtained from the famous *lychnites* marble exploited in the galleries of Stephani, thus probably indicating the presence of a specialized atelier active on the Island of Paros in the 5th c. BC.

IASOS AND THE IASIAN MARBLE BETWEEN LATE ANTIQUE AND EARLY BYZANTINE TIMES

Fede BERTI,[1] Diego PEIRANO[2]

[1]Via Bugaro 6, Ferrara, Italy (fede.berti@alice.it)
[2]Association Iasos of Caria, Ferrara, Italy (diego.peirano@polito.it)

Keywords: Use of marble, Iasos, furniture

Iasian marble, although already known before, seems to reach the highest point of its reputation in the 6th century, when it appears as a part of three of the most important edifices built by Justinian: the Constantinopolitan churches of Hagia Sofia and of Holy Apostles, and San Vitale in Ravenna. In the same period, between Late Antique and Early Byzantine eras, the attestations of the three variants of this material became more frequent also in Iasos. Even if these ones are almost always related to architectonic uses, vessels and spindle whorls are also attested. According to the function, the *cipollino* variety is sometimes used, but the *brecciated* variety was employed to a greater extent.

The raw blocks found in Balık Pazarı pertain to architectonic purposes, some ready to be sawn into slabs; and so do the columns and colonnettes discovered in the neighborhood quarries and in two of the Iasian churches. Here the marble appears also as mosaic *tesserae* in the acropolis basilica and as tiles in the agora basilica. Also, items of furniture such as tables made by *marmor iassense*, both rectangular and sigma-shaped, were found on secondary places everywhere in Iasos. Upon these elements and on others based on imported marbles, a study concerning shapes, processing techniques and functions is in progress by our research unit. Preliminary results will be presented.

TRACES OF STONE EXPLOITATIONS UNDER THE SEA - THE ANCIENT QUARRY SITE IN SREBRENA BAY ON THE ISLAND OF VIS

Jurica BEZAK

Croatian Conservation Institute, Department for Underwater Archaeology, Zagreb, Croatia (jbezak@h-r-z.hr)

Keywords: ancient quarry, seabed, maritime transport of stone

During 2012 and 2013 a team of experts from the Department for Underwater Archaeology of the Croatian Conservation Institute conducted an underwater archaeological survey of Srebrena Bay on the island of Vis. Research conducted at this site uncovered one of the oldest quarries on the eastern Adriatic coast, dated to the period of Classical Antiquity. The exploitation of stone on Vis began with the arrival of Greeks at the beginning of the 4th century BCE, when the Greeks founded Issa, their first colony in the Adriatic. The quarry in Srebrena Bay is settled 7 nautical miles from the town Vis, the ancient Issa, on a location that enabled the transport of stone only by sea. The survey of the seabed around the quarry yielded traces of the very beginning of stone exploitation, along with a lead stock of an ancient anchor. Traces of stone splitting, a series of uniformly made canals found at a depth of 1.8 meters, unequivocally prove quarrying at the site during Antiquity and also bring useful information on the rising of the sea level. The lead anchor stock from Srebrena Bay weighs around 800 kg and, according to research conducted in Croatian Waters, it is the biggest one found so far. Considering the context of the site the anchor can be attributed to a larger vessel with a great bearing capacity, used for transportation of stone blocks from the quarry during Antiquity.

ACHITECTURAL DECORATION OF THE IMPERIAL AGORA'S PORTICOES AT IASOS

Fulvia BIANCHI,[1] Donato ATTANASIO,[2] Walter PROCHASKA[3]

[1]Via Monte Pertica 21, Rome, Italy (fulviabianchi@yahoo.it)
[2]Istituto di Struttura della Materia, Consiglio Nazionale delle Ricerche (ISM-CNR), Rome, Italy (donato.attanasio@ism.cnr.it)
[3]Department of Applied Geological Sciences and Geophysics, University of Leoben, Leoben, Austria (walter.prochaska@unileoben.ac.at)

Keywords: Iasos' agora, architectural decoration, craftsmen, archaeometric identification

During the first centuries of imperial age, the city of Iasos located on the Gulf of Mandalya in Caria, underwent intense urbanistic activity. A new district was built on the southern slopes of the hill and the city was connected to a new aqueduct, while some of the existing public buildings were embellished, including the scene of the theater, the Bouleuterion and the porticoes of the central agora, which, as known by the inscription engraved on the architrave of the eastern side, were erected between 135 and 138 AD. Up to now only the agora and the Bouleuterion were studied by E.Pagello and R. Parapetti in the 1980s dealing only with the general architecture of both monuments without considering the decorative aspects, the ornamental patterns and the provenance of the craftsmen. The marble provenance of the porticoes of the agora, was loosely assumed to be Aphrodisias, Stratonikeia and Milas. In fact it could be noticed that a white coarse grain marble was used for the entablatures, the column capitals and bases, while a coarse gray marble with parallel stepped veins was employed for the column shafts of the porticoes of the agora and the pedestals of the central colonnade of its southern side. The present study deals with the porticoes of the Agora in particular with its decoration patterns, the ateliers of stonemasons active in Asia Minor and the different marbles used for this building project. The recent discovery of a large white marble quarry district at Milas and a gray one at Euromos has suggested to verify more precisely previous hypotheses on the origin of the marbles used in the Iasos' Agora. For this purpose several architectural elements in white and gray veined marbles were sampled and submitted to archeometrical analyses (EPR, trace analysis and carbon and oxygen isotopes) in order to define

exactly their provenance. The analytical results allowed to exclude the use of Aphrodisias and Stratonikeia marbles and to confirm the employment only of the local white marble from Milas and the gray stepped one from Euromos. This new evidence allowed to reconsider the question of the origin of the decorative patterns and cultural tradition of the stonemasons active in Iasos during the imperial period.

POLYCHROME MARBLES FROM THE PYTHION'S THEATRE IN GORTYNA (CRETE)

Jacopo BONETTO,[1] Michele BUENO,[2] Nicolò MARESO[1]

[1]Dipartimento di Beni Culturali, Università degli Studi di Padova, Padua, Italy
(jacopo.bonetto@unipd.it; nicomareso@gmail.com)
[2]Soprintendenza Archeologica della Toscana, Florence, Italy
(michele.bueno@beniculturali.it)

Keywords: Gortyna of Crete, theatre, coloured marble

Since 2001 the Italian Archaeological School of Athens and the University of Padua (Dept. of Cultural heritage) have carried out archaeological excavations at the Pythion's Theatre in Gortyna (Crete), highlighting different historical phases of the building from the construction in the 2nd century AD till the collapse in 365 AD. Based on macroscopic characterization, all marble fragments coming from the excavation have been collected in a database where the features of the items are determined: lithotype, size, weight, traces of workmanship, function. This paper presents the study of coloured marbles, to date not yet published, and aims to reconstruct the decorative programme of the theatre and the wide commercial horizon of Gortyna in marble trades. A close look reveals that various marble sources were used to decorate the theatre with predominance of lithotypes coming from Greece and the North-western part of Anatolia: *Cipollino Rosso, Pavonazzetto, Cipollino Verde, Breccia Sciro, Breccia Corallina*. A great part of examined fragments are slabs, with a high degree of fragmentation, coming from floor and wall decoration.

FAUX MARBLING MOTIFS IN EARLY CHRISTIAN FRESCOES IN CENTRAL AND SOUTHERN DALMATIA

Tonči BOROVAC,[1] Antonija GLUHAN,[1] Nikola RADOŠEVIĆ[2]

[1]Croatian Conservation Institute Split, Split, Croatia
(tborovac@h-r-z.hr; agluhan@gmail.com)
[2]Academy of Arts, University of Split, Split, Croatia (radniko@gmail.com)

Keywords: Faux marbling, Conservation-restoration, Central and Southern Dalmatia

Throughout history, the faux marbling technique was used as a more accessible substitute for natural marble and stone in decorating representative parts of objects of religious and secular use. The term describes a technique where different types of substrata are painted in order to achieve the effect that mimics the layout of the original stone material. Starting from Antiquity, the faux marbling technique reached its peak in the Roman Empire, but the use was considerably reduced during the Middle Ages, until the Renaissance brought a renewed interest and significant application, continuing with the extensive use during the Baroque period and later styles to the mid-20th century. The significance of this decorative technique in Dalmatia was expressed in the art of the Early Christian period, when reductions in the marble and stone market occurred due to the decline of the Roman Empire.

The history of the faux marbling technique is insufficiently researched and inadequately evaluated, especially along the eastern Adriatic coast. The aim of this paper, based on a few representative examples of marbling motifs executed in fresco technique, is to investigate the historical and artistic context and the reasons for intensified use of the faux marbling technique during the Early Christian period in Central and Southern Dalmatia. Valorisation, preservation and technological fabrication of representative examples of the technique will be presented through a series of conservation and restoration works on the sites. Also, the study will try to determine which types of natural marbles or stones correspond to the presented examples of faux marbling. The aim of this comparison is to lay the foundation for creating a database in order to classify types and origin of marble and stone used as templates in the implementation of imitations fabri-

cated using the technique of faux marbling. Representative examples of faux marbling on a number of sites in Central and Southern Dalmatia, by monitoring and reviewing the historical development and methods of application techniques presented in this paper are the Basilica of St. Lawrence, Lovrečina in Bol (Brač), the Church of SS. John and Theodore in Bol (Brač), the Early Christian baptistery of the Church of St. John the Baptist in Povlja (Brač), the remains of fragments in the Episcopal complex in Salona (Solin), the baptismal font at St. Vitus (Vid near Metković).

THE DIFFERENT STEPS OF ROUGH-HEWING ON A MONUMENTAL SCULPTURE FROM THE GREEK ARCHAIC PERIOD: THE UNFINISHED KOUROS OF THASOS

Danièle BRAUNSTEIN

Musée du Louvre, Paris, France (daniele.braunstein@louvre.fr)

Keywords: tools, rough-hewing, stone-cutters

By looking for the marks of tools on Greek archaic marble sculptures, I studied the colossal unfinished kouros from Thasos, from the mid 6th c. B.C. exhibited in the Archeological Museum of Thasos. This study allowed me to suggest a reconstruction of different steps from rough-hewing, started in the quarry after the extraction of the block and finished in the place where the statue was exhibited.

Marks of only one tool can be seen on this sculpture: the point. However, these marks are not all the same. In fact, there are four types of marks which correspond to four different ways of using the point, and to each way of using the point, corresponds one step of rough-hewing of the sculpture. After that, it is possible to deduce a certain number of hypotheses about the work in a quarry, the work in the place of exhibition or in the workshop, the order of operations on the statue and the different crafts (stone-cutters, sculptors, specialized sculptors).

Therefore, the study of marks of only one tool on this unfinished kouros from Thasos allows a much better understanding of the process of making a statue in the Archaic period and the importance of the role of stone-cutters in rough-hewing of sculptures.

THE BEGINNING OF THE "MARMORIZATION" PROCESS OF THE MONUMENTAL BUILDINGS ON THE PALATINE HILL IN THE AUGUSTAN AGE: CHARACTERIZATION OF WHITE MARBLE OBJECTS FROM THE TEMPLE OF APOLLO AND THE HOUSE OF AUGUSTUS

Mauro BRILLI,[1] Francesca GIUSTINI,[1] Patrizio PENSABENE[2]

[1]Istituto di Geologia Ambientale e Geoingegneria, CNR, Rome, Italy
(mauro.brilli@igag.cnr.it; francesca.giustini@igag.cnr.it)
[2]Dipartimento di Scienze Archeologiche, Università La Sapienza, Rome, Italy
(patrizio.pensabene@uniroma1.it)

Keywords: white marbles, isotopes, petrography, Palatine Hill

This work aims to characterize twelve samples from marble artifacts collected in the Temple of Apollo and the House of Augustus at the Palatine Hill during archaeological excavations in Rome. Two of these samples are from statues, one of which is likely the Apollo statuary representation; the other samples are from architectural elements (columns, capitals, plates and cornices). The marbles of the Augustan complex represent the first examples of a change in the building materials for monumental architecture at the Palatine Hill in the Augustan age, in other words they started the "marmorization" process in the area. In this context, it is important to determine if the marble artifacts that were subjects of religious cult were originals from Greece or copies that were carved during the building of the Augustan complex. In order to discriminate between these two possibilities, it is necessary to identify the geographic location where the marbles considered were quarried.

In this work petrography and isotopes of carbon and oxygen of the marbles were tentatively used to discriminate the quarry provenance of the artifacts. The combination of these techniques can be an effective way of determining the provenance of ancient marbles, as the relevant archaeometric literature has largely demonstrated.

In our selection of samples, it is evident that most of the architectural elements are made of marble of Italic provenance, while the statues that refer to the religious cult, seem to have Greek, or any exotic, origin.

PAINTING CONSERVATION AND SCULPTURES OF TWO GALLO-ROMAN TEMPLES IN PICARDY: CHAMPLIEU AND PONT-SAINTE-MAXENCE

Véronique BRUNET-GASTON,[1,2] Christophe GASTON[1]

[1]Institut National de Recherches Archéologiques Preventives, Besançon, France
(Veronique.gaston@inrap.fr; christophe.gaston@inrap.fr)
[2]Institut de Recherche sur l'Architecture Antique, Aix-en-Provence, France

Keywords: Painting, sculptures, sanctuary, Champlieu, Pont-Sainte-Maxence

Two archaeological sites in the Oise: the temple of Champlieu and the sanctuary of Pont-Sainte-Maxence reveal the prowess of the decoration from buildings dated between the Antonine and the Severan age.
Made in local rocks (Lutetian benches), the stoneworks are enhanced by colors seen at discovery. The sculptures have a specific Hellenistic Greek sculpture expression and special mythological themes.
The two sites are situated along a Roman road.
Champlieu shows the vicissitudes of time of discovery in the nineteenth century and Pont shows the collapse of the following disorder at the foundation mechanism. Pont, the very fresh sculpture, seems to have suffered very little erosion, suggesting a lifetime of the façade rather limited in time.

UNKNOWN QUARRY INSCRIPTIONS FROM THE BACAKALE QUARRY AT *DOCIMIUM* (TURKEY)

Matthias BRUNO

Via dei Vascellari 34, Rome, Italy (matthiasbruno@libero.it)

Keywords: Quarry inscriptions, Docimium, Bacakale

The quarry production system is now well known thanks to the archaeological, epigraphic and historical evidence from many Roman imperial marble quarries. The inscriptions on the quarry items discovered in the extraction sites or in the depots in Rome and Ostia clarify how strict the control of the yearly production was. The *Docimium* quarry district, north from Afyonkarahisar, and close to the village of Iscehisar, was one of the most important extraction sites in Roman Antiquity, producing one of the most famous and prestigious Roman imperial marbles, the *marmor phryigium*, known today also as Pavonazzetto, exploited since the late Augustan age. The ancient quarries of *Docimium* are not so well preserved anymore, due to the intense modern exploitation of the marble outcrop. However, during the last 40 years, hundreds of marble blocks and column shafts were discovered and saved first in some depots close to the modern extraction pits, and then put on display along the main central road of the small town of Iscehisar. All these items, and especially their epigraphic evidence, allowed to obtain, thanks to the studies of several scholars, as M. Christol, Th. Drew-Bear, J.C. Fant, P. Pensabene, M. Waelkens, important data about the extraction activity at *Docimium* in Roman times. The quarry marks and inscriptions affirm in fact a strict control, indicating not only the intraquarry provenance, the extraction place, distinguished into *loca* and *bracchia*, the *caesurae* and the *officinae* involved in the excavation, the production year but, sometimes the consular date of a recounting of the rough quarry items left in the yards of the quarries or in the depots of the *Urbs*.
A survey in the large quarry area of Bacakale discovered several unknown inscriptions and marks painted in red colour on some quarry fronts. This epigraphic evidence, which can probably be dated to the mid imperial period, shows that the strict production control was not limited only to the produced quarry items, but in fact extended to the quarry sites, where, the periodical extracted amount was signed on the extraction faces.

EUROMOS OF CARIA: THE ORIGIN OF A HITHERTO UNKNOWN GREY VEINED STEPPED MARBLE OF ROMAN ANTIQUITY

Matthias BRUNO,[1] Donato ATTANASIO,[2] Walter PROCHASKA,[3] Ali Bahadir YAVUZ[4]

[1]Via dei Vascellari 34, Rome, Italy (matthiasbruno@libero.it)
[2]Istituto di Struttura della Materia, Consiglio Nazionale delle Ricerche (ISM-CNR), Rome, Italy (donato.attanasio@ism.cnr.it)
[3]Department of Applied Geosciences and Geophysics, University of Leoben, Leoben, Austria (walter.prochaska@unileoben.ac.at)
[4]D.E.Ü Engineering Faculty, Geological Engineering Department, Izmir, Turkey (bahadir.yavuz@deu.edu.tr)

Keywords: Euromos, Caria, marble provenance, archaeometry

Marbles were quarried in Roman Antiquity all over the Mediterranean basin from east to west, and Asia Minor was certainly one of the most important exploitation areas. White and coloured marbles were quarried since the 1st century BC in western Anatolia and distributed in Rome and several cities of the Roman Empire. Caria was an especially marble-rich area and produced several important marbles extracted close to the ancient cities of Aphrodisias, Mugla, Stratonikeia, Milas and Iasos.

During a site survey in western Anatolia (Turkey) in 2012, a new unknown marble quarry was discovered near the ancient city of Euromos (Milas), where a very typical grey veined stepped marble was extracted. The large quarry district, with well preserved excavation fronts, is located on top and along the slopes of the hill close to the ancient town, and several unfinished column shafts still lie in some of the extraction areas.

A systematic archaeological investigation of the quarry site was undertaken and extensive sampling was carried out for archaeometrical analyses (isotopes, trace analysis, EPR) in order to obtain a reference data bank to be compared with other ancient similar marbles, even if the macroscopic aspect of the Euromos marble allows easy preliminary autoptic distinction, thanks to the frequent presence of stepped grey veins, due to shear fractures of the marble outcrop.

The use of the Euromos marble in Roman Antiquity was not limited only to the regional area, where it was employed for the column shafts of the

Zeus temple at Euromos and the porticoes of the Roman agora at Iasos, both of Hadrianic period. The grey veined stepped Euromos marble spread out all over the Roman Empire probably from the Hadrianic period onwards and it could be recognized in several coastal cities of Asia Minor, as Knidos, Kaunos, Perge, Side and Elaiussa Sebaste, in Palestine, at Caesarea Marittima and Hippo Sussita, in North Africa at Leptis Magna, and obviously also in Rome, Ostia and some other cities of southern Italy.
Having a typical veined aspect, the Euromos marble was probably considered a kind of coloured marble in Roman times and its large use and diffusion testify to its important role in the Roman marble trade.

COLOURED MARBLES IN THE WESTERN PART OF *REGIO X* (*VENETIA ET HISTRIA*): THE ROMAN VILLAS OF TOSCOLANO AND DESENZANO DEL GARDA (ITALY)

Roberto BUGINI,[1] Luisa FOLLI,[2] Elisabetta ROFFIA[3]

[1]CNR-ICVBC, Milan, Italy (bugini@icvbc.cnr.it)
[2]CNR-ICVBC, Lodi, Italy (lufo@fastwebnet.it)
[3]Soprintendenza Archeologica Lombardia, Milan, Italy (Isa.roffia@tiscali.it)

Keywords: opus sectile, Roman Lombardy, Lake Garda villas

The shore of Lake Garda (*Benacus*), in the western part of the *Regio X* (now Brescia province, Lombardy), hosts some of the richest and best preserved Roman villas of Northern Italy. They exhibit several architectural characters of the enchanting *villae maritimae* of Central Italy. Two Lake Garda villas represent the most interesting example owing to the complexity of the architectural plan and the grandeur of the decorations with mosaics, paintings and sculptures. These villas, built at the end of the 1st century BCE, were inhabited until the beginning of the 5th century CE and the present-day remains pertain to the 2nd century phase (Toscolano) and to the first half of the 4th century phase (Desenzano): in both cases the buildings significantly changed the architectural plan and room decoration. A considerable amount of pieces of coloured marble were found in both sites together with parts of white marble statues.

Coloured marbles were identified using the traditional investigations, in comparison with marble samples specifically kept in different quarries around the Mediterranean basin.

The marbles of Toscolano villa are: Africano, Breccia corallina, Breccia Settebasi, Cipollino, Giallo antico, Greco scritto, Palombino, Pavonazzetto, Porfido rosso antico, Porfido serpentino verde, Rosso antico. The marbles of Desenzano villa are: Africano, Breccia Settebasi, Cipollino, Fior di Pesco, Giallo antico, Greco scritto, Pavonazzetto, Portasanta, Porfido serpentino verde, Rosso antico, Verde antico.

The typology of the pieces is variable according to the lithology: slabs of different shape and thickness (*opus sectile*) for carbonate stones as Cipollino, Giallo antico, Palombino, Pavonazzetto, Portasanta etc.; mouldings for silicate stones as Porfido rosso and Porfido verde. Skirting boards and

carved architectural elements connote the Rosso antico. The original edges, with varying contours, are often conserved and scraps of mortar last on the surface of some pieces. The spreading of coloured marbles in the western part of *Regio X* is also evidenced by the pieces found in other sites: *villa* at Faustinella (near Desenzano), *domus* Ortaglia (Brescia), *villa* at Nuvolento (near Brescia) and *domus* at Piazza Marconi (Cremona): almost the same lithotypes as in the Lake Garda villas were identified here.

COLOURED MARBLES IN THE NEAPOLITAN ARCHITECTURE (16th AND 17th CENTURIES): THE CHURCH OF SANTI SEVERINO E SOSSIO

Roberto BUGINI,[1] Luisa FOLLI,[2] Martino SOLITO[3]

[1]CNR-ICVBC, Milan, Italy (bugini@icvbc.cnr.it)
[2]CNR-ICVBC, Lodi, Italy (lufo@fastwebnet.it)
[3]Martino Solito Restauro, Taranto, Italy (Info.martinosolitorestauratore@libero.it)

Keywords: inlaid stone, Baroque, Naples

A significant feature of Neapolitan architecture during the 16th and 17th centuries is the use of coloured marbles for floors, veneering, altars balustrades, columns etc. A fine example of this feature is the church of *Santi Severino e Sossio*, holding a 16th century nave floor and a 17th century presbytery. The church pertains to one of the oldest, biggest and richest monasteries of Naples, seat of the Archivo di Stato since 1835. The nave floor was completed in the late 16th century; the presbytery, planned by Cosimo Fanzago, was made in 1635-41 and its floor was achieved in 1697. The recent conservation works of the monastery allowed to examine the nave floor and the presbytery on the basis of a macroscopic survey.

Nave floor - A square framework is made of marbles (white, black veined, grey - Apuanian Alps) directly supplied for this purpose and cut in geometrical shapes. The ornamental parts were made of coloured marbles of both original and secondary use, cut in curvilinear shapes and often inlaid. The first ones are: Broccatello (Spain), Giallo Siena (Tuscany), Libeccio (Sicily). The second ones are the marbles featuring the Roman architecture: Africano, Breccia corallina (Turkey); Fior di pesco, Portasanta, Verde antico (Greece); Giallo antico (Tunisia); the absence of igneous lithotypes (granite, porphyry etc.) is remarkable. Coloured marbles were used in Roman buildings of *Neapolis* and the surrounding towns as *Cumae, Puteoli*, *Capua* etc., and then were extensively reused in the Middle Ages onwards.

Presbytery - The balustrade (short pillars, transennae) is made of white Carrara marble; the coloured marbles (Broccatello, Fior di pesco, Giallo antico, Libeccio, Verde antico) are set as *commesso alla fiorentina* (inlaid stone). *Commesso* ornamentations are outspread in other Neapolitan churches made by Fanzago and his atelier. The floor framework is made of

white marble and black limestone (Lombardy? - Flanders?) together with floral patterns made of Broccatello, Libeccio, Giallo Siena, Giallo antico, Rouge Languedoc, Verde antico and *pietre dure* (diaspro, calcedonio, agate). In the church of *Santi Severino e Sossio*, the decades separating the nave floor and the Fanzago's presbytery show a different technique in the application of coloured marbles: thick slabs cut in geometrical shape change to thin slabs cut in fantastic manner.

MULTIPLE REUSE OF IMPORTED MARBLE PEDESTALS AT CAESAREA MARITIMA IN ISRAEL

Barbara BURRELL

Department of Classics, University of Cincinnati, Cincinnati, Ohio, United States
(barbara.burrell@uc.edu)

Keywords: imported marble, reuse of stone, inscriptions

In 1990, two columnar statue bases were found by a University of Pennsylvania Museum expedition digging at the Promontory Palace (identified as the Palace of Herod the Great, later the Praetorium of the Roman governors of the province) at Caesarea in Israel. They lay side-by-side in the ruins of what had been a hypocaust-heated room, with dating material no later than the Tetrarchy. Though the inscriptions on the pedestals were published in 1993, less notice was taken of the unusual grey marble, with stepped bands in dark grey to black, of which both were made, and how the bases were used and reused over the years.

Visual analysis has now given a preliminary identification to the marble of the two bases, and the results of isotopic analysis are in process of being analyzed, as well as included in internationally-compiled databases of such *bigio*-type marbles.

The placement and erasure of the inscriptions shows that each base was used at least four times after its initial import and use in Caesarea, having been turned or even flipped over to provide a new surface for inscription and an emplacement for the statue(s). There are other examples of this phenomenon at Caesarea, which like the rest of Israel had no native marble, and this study will show at what periods such intense reuse of marble occurred.

THE MARBLE DEDICATION OF KOMON, SON OF ASKLEPIADES, FROM EGYPT: MATERIAL, PROVENANCE, AND THE REINFORCEMENT OF MEANING

Patricia A. BUTZ

Art History Department, Savannah College of Art and Design,
Savannah, Georgia, United States (pbutz@scad.edu)

Keywords: Marble sourcing, Greeks in Egypt, Dedicatory inscriptions

This paper concerns a marble dedicatory plaque inscribed in Greek on display in the collection of the Metropolitan Museum of Art in New York (Inv. 89.2.652). It was dedicated on behalf of Ptolemy IV Philopater and Ptolemy V Epiphanes by Komon, son of Asklepiades, identified also as *oikonomos* in the region of the Greek settlement at Naukratis.

The presence of marble is of great interest because of the rarity of its occurrence in Egypt, leading to the question why the imported material was used for this particular inscription dated internally to the last quarter of the third century. Initial testing of the stone was conducted by Norman Herz, University of Georgia, who suggested three possible quarries from the isotopic analysis: Doliana, Thassos/Akropolis, and Afyon. A more recent study by Donato Attanasio, Istituto di Struttura della Materia del CNR in Rome, includes MGS and EPR properties in the analysis. The results indicate (with some doubt) that the marble is Dokimeion from Afyon or, perhaps, Altintas.

Modest though the plaque is, measuring 28.0 cm in length and 17.7 cm in height and formulaic in its textual content, it comprises six lines of exceptional lettering and careful disposition of the parts of the formula. The MGS of the marble, given as 0.9 mm, is one factor allowing precision in lettering technique. While determining the origin of the marble is still cautionary, the paper discusses the Dokimeion provenance that appears strongest in the latest report and the meaning implied by Komon's choice of marble for this dedication.

"HOW DO YOU, BROTHER, BREAK YOUR CHISEL?" - PICTURE OF EVERYDAY LIFE OF ANCIENT STONEMASONS

Marija BUZOV,[1] Vesna LALOŠEVIĆ[2]

[1]Institute of Archaeology, Zagreb, Croatia (marija.buzov@iarh.hr)
[2]Zagreb, Croatia (vesnalalosevic@yahoo.com)

Keywords: masons, quarry, an early Christian legend, daily life, Pannonia, Moesia

Late antique written sources of early Christian provenance contain various pieces of information about the appearance of quarries and the stonemasons' craft. The entire process from receiving an order to the final decoration of buildings is given, which reflects everyday life of stonemasons. Based on data from written sources we will try to show the finds that illustrate the appearance of the quarry and the work of ancient stonemasons.

ANTIQUE SALONITAN QUARRIES ON THE ISLAND OF BRAČ

Radoslav BUŽANČIĆ

Conservation Department Split, Split, Croatia (radoslav.buzancic@gmail.com)

Keywords: Antique quarries, Split, Diocletian's Palace, Salona

Diocletian's time brought about many changes to Dalmatia's economic makeup, in which stone production played an important role. Quarries were the Emperor's property, and the stone was mined and processed by slaves, largely convicts, who were supervised by the military commanders of the legions. Removing large blocks from the quarries was a painstaking process, and work on the blocks themselves, along with any finishing touches, was done in the same place where other architectural elements, such as pillars, capitals, and beams, were manufactured. Completed products were then shipped from the quarries to the destination they were ordered for.
We know that the stone used in Diocletian's Palace in Split was mined from the Brač quarries in Plate, Rasohe, and Zastražišće, near Škrip. An often overlooked fact, however, is that Diocletian's building endeavors in the Illyrian capital of Salona were even larger in scope than those of the Palace, which nearly doubled in size during his time. A series of findings from Škrip, bearing inscriptions that mention a centurion from a Belgian cohort who called himself *curagens theat(ri)* from Salona, and an inscription from a sacrificial altar dedicated to Jupiter by Titus Flavius Pompeii, a centurion from the third Alpine cohort who oversaw the construction of Split's amphitheater, *curam agens fabricae amphitheatri*, show that the quarries were run by military commanders tasked with overseeing construction on various sites in the area. One of them mentions a supervisor for the capitals made for Licinius' spas in Sirmium. This fact points to the export of stone goods to far away places. Stone would be transported by ship from Splitska harbor, where it was brought to from the quarries of Škrip, using ramps. The stone trade was very well developed in Roman Dalmatia. Various types of marble that were not common in these parts were brought over, while high-quality limestone, suitable for sculpting, was exported to various parts of the Empire. This continued well after Diocletian's time.

The Forum of Valens in Anitoch, according to Malalas, was decorated with pillars from Salona. The origin of the stone pillars from The Chronicle of Malalas was previously identified by Carl Müller, who thought they came from Salona in Illyria. In The Chronicle of John Malalas, he considered the *columnis ingentibus saloniticis* to be stone from Trogir's quarries near Salona, which Plinius praised in his Naturalis Historia III 22. It is, however, more likely that they came from quarries on Brač, which at the time included more than just those that we are familiar with today, near Splitska, such as the Veselje quarry near Stipanska harbor in modern day Pučišća, which, due to the exceptional quality of its stone, was once again tapped in the 15th century by Renaissance builders.

THE QUARRIES OF THE MAĞARA DERESI AND THE MARBLE OF THE TEMPLE OF ARTEMIS AT SARDIS

Nicholas CAHILL,[1] Lorenzo LAZZARINI[2]

[1]Department of Art History, University of Wisconsin, Madison, Wisconsin, United States (ndcahill@wisc.edu)
[2]Laboratorio di Analisi dei Materiali Antichi - Sistema dei Laboratori - Università IUAV di Venezia, Venice, Italy (lorenzo@iuav.it)

Keywords: Sardis, Artemis Temple, Mağara Deresi, Archaeometry

Samples of marble from the Mağara Deresi quarries near Sardis and from Lydian, Hellenistic, and Roman buildings from the site were analyzed using minero-petrographic and isotopic analysis. The samples from the quarries provide the first detailed petrographic descriptions of this marble, while the isotopic analysis enlarges the known isotopic field, which overlaps the field for Ephesian marble, requiring petrographic examination to distinguish between the two. Results of analysis from the sanctuary of Artemis at Sardis show that the Hellenistic and Roman portions of the temple were both built from marble from the Mağara Deresi. A block reused as spolia, however, is isotopically similar to samples of Lydian marble buildings analyzed previously, and may come from quarries north of the Gygaean Lake.

STABLE ISOTOPE ANALYSIS OF THE WHITE MARBLE SCULPTURES FROM THE SAINT LOUIS ART MUSEUM

Lisa Ayla ÇAKMAK,[1] Scott H. PIKE,[2] Emily HAMILTON[3]

[1]Saint Louis Art Museum, St. Louis, Missouri, United States (lisa.cakmak@slam.org)
[2]Deptartment of Environmental and Earth Sciences, Willamette University, Salem, Oregon, United States (spike@willamette.edu)
[3]San Francisco Museum of Modern Art, San Francisco, California, United States (ehamilton@sfmoma.org)

Keywords: white marble, stable isotope analysis, mass spectroscopy

In the summer of 2014, 16 white marble sculptures from the collection of the Saint Louis Art Museum were sampled and analyzed using stable isotope analysis. The objects chosen comprise the entire corpus of ancient white marble sculptures in the collection and range in date from the Early Bronze Age to Late Antique Period. The aim of the current study was to (1) determine the source quarries of each of the marble varieties and (2) assess the consanguinity and variety of marbles used in sculptures composed of multiple fragments. This paper presents a selection of the results in order to demonstrate the utility of scientific analyses to the study of objects where provenance and original context are irrevocably lost. Results include the unexpected match of the base and top of a cinerary urn as well as the provenance of a Roman relief block that was reused for a 16th century sculpture of *Reclining Pan*. Although stable isotope analysis was able to provide revealing and useful information, it is also apparent that a multi-method approach using EPR would improve our ability to distinguish between marble varieties for some of the sculptures.

PRODUCTION OF LOCAL LIMESTONE STATUARY AND SARCOPHAGI IN DALMATIA

Nenad CAMBI

Croatian Academy of Sciences and Arts, Split, Croatia (Nenad.Cambi@xnet.hr)

Keyword: sculpture, sarcophagus, limestone, Salona, island of Brač

Stone quarrying was a very important branch of economy in Dalmatia which began already in prehistoric periods. The only suitable material for such exploitation was limestone. However, there is a large range of quarries which greatly differ in quality. According to its quality, limestone was utilized for different purposes (architecture, architectural decoration or sculpture). Greek colonists were the first to extract stone on a larger scale. They opened quarries on the islands of Vis, Hvar, Brač, as well as on the shore, near Trogir and Stobreč. After the beginning of Roman domination, bigger quantities of the local limestone were gradually quarried at many sites. Roman emperors soon realized the benefit of stone quarrying, seizing the most profitable ones. This is evidenced by soldiers' inscriptions testifying to their administration of quarries and guidance of the whole process of works. They controlled the orders, delivery of stone products for different buildings (amphitheatre in Salona, Licinian thermae in Sirmium). Such epigraphs were found on the island of Brač and at Seget near Trogir. The best local limestone which was good enough for all types of statuary was quarried at Seget near Trogir. The Brač limestone was mostly used for sarcophagi which is why Pliny the Elder wrote: *Tragurium marmore notum*. The sarcophagi workshops were developed and profitable. Half-finished sarcophagi blocks were exported from the Brač quarries to Salona and all around Dalmatia. Approximately 2000 sarcophagi or their fragments have been registered so far. But, new pieces appear every day. The statuary, sarcophagi and other funerary monuments were not exported outside Dalmatia. However, the local limestone began to be exported on the other side of the Adriatic coast in Late Antiquity. It is very well known that the huge monolith top of Theodoric's Mausoleum in Ravenna was made of Istrian limestone. The sarcophagi of local Dalmatian workshops were exported to the western Adriatic (Italian) littoral. They are mostly sarcophagi chests,

especially pieces showing crosses and *paterae* in shallow relief on the front. The lids were simple with four *acroteria*. There are several types of central crosses. The idea of a central cross was also used for the church *plutea*, but far less than for sarcophagi. Since a large number of such sarcophagi were found in Salona and on the island of Brač, they were obviously produced there. Apart from Dalmatia such sarcophagi were discovered in Ravenna, Bari, Trani, Barletta etc. One example was found also in Albania. About 80 such pieces were registered until now.

On the other hand, the statuary and luxury objects were made of the marble from regions of Attica and the island of Prokonnesos. There are also some sculptural pieces of white unidentified marble. The fine Proconnesian marbles were transported in roughly cut blocks and finished in local workshops. The late examples of sarcophagi began to be exported in the 5th and 6th centuries. Obviously, some regions in Italy experienced the economic crisis, giving way to the import of cheaper limestone from Dalmatia and Istria.

ADDITIONAL CATHODOLUMINESCENCE MEASUREMENTS TO DETERMINE THE PROVENANCE OF MARBLE SCULPTURES FROM THE NATIONAL MUSEUM OF CARTHAGE (TUNISIA)

Lluís CASAS,[1] Hernando ROYO PLUMED,[2] Nejia LARIDHI,[3] Marta MORENO-VIDE,[4] Aureli ÁLVAREZ[1]

[1]Universitat Autònoma de Barcelona, Facultat de Ciències, Departament de Geologia, Campus de la UAB, Bellaterra, Spain (Lluis.Casas@uab.cat; Aureli.Alvarez@uab.cat)
[2]Institut Català d'Arqueologia Clàssica (ICAC), Tarragona, Spain (hroyo@icac.cat)
[3]Université de Tunis El Manar, Faculté des Sciences, Unité de Recherche: Pétrologie Cristalline et Sédimentaire, Département de Géologie, Campus Universitaire, Tunis, Tunisia (Nejia.ouazaa@gmail.com)
[4]Universitat Autònoma de Barcelona, Facultat de Lletres, Departament d'Art, Campus de la UAB, Bellaterra, Spain (mmvide@hotmail.com)

Keywords: Provenance, Cathodoluminescence, Archaeometry, White marbles, Carthage, Petrography

The National Museum of Carthage lies on top of the Byrsa hill, where the acropolis of the Roman Carthage (built on the ruins of the Punic city) sat. The museum holds the largest collection of objects from the archaeological site including sculptures, inscriptions and sarcophagi. In 2012, the personnel from the Tunisian Institut National du Patrimoine authorised us to sample 14 items (sculptures and sarcophagi) from the museum to identify or confirm their provenance. In 2013 we already published the obtained results of an archaeometric study using a combined minero-petrographic and stable-isotope approach [1]. Out of the 14 items, nine were attributed to a Pentelikon source, three were identified as Carrara marble and one as Prokonnesos. A particular well-executed sculpture (item 1 in [1], depicting the Genius Coloniae Carthaginis, was made with a quite transparent marble. The marble of this item was initially indentified as Paros lignite although the isotope data did not match with such attribution and suggested a Pentelikon source.

We have now added cathodoluminescence (CL) measurements to the 14 samples. The results mostly confirm the interpretations already published. All three Carrara- and the Prokonnesos-attributed items exhibited their corresponding known CL signal. The Pentelikon source was also con-

firmed for six items (including the controversial item 1). Finally, four items, identified in [1] as Pentelikon, exhibited an uncommon CL fabric. These anomalous Pentelikon CL fabrics along with the anomalous transparency of the Genius Coloniae Carthaginis will be subject of further investigation.

[1] Provenance of marble sculptures from the National Museum of Carthage (Tunisia). Nejia Laridhi Ouazaa, Lluís Casas, Aurelki Álvarez, Boutheina Fouzai, Marta Moreno-Vide, Laurence Vidal, Roudosli Sihem, Corinne Sonzogni, Daniel Borschneck. Journal of Archaeological Science 40 (2013) 1602-1610.

ORNAMENTAL ROCKS USED IN THE ARCHITECTURE AND EPIGRAPHY OF LABITOLOSA (*CONVENTUS CAESARAUGUSTANUS*, *PROVINCIA HISPANIA CITERIOR*)

Miguel CISNEROS,[1] Josep GISBERT[2]

[1]University of Cantabria, Santander, Spain (miguel.cisneros@unican.es)
[2]University of Zaragoza, Zaragoza, Spain (gisbert@unizar.es)

Keywords: petrography, cost, elites

The municipium of Labitolosa (La Puebla de Castro, Huesca, España) is strategically situated at the confluence of the rivers Isabena and Esera, controlling access to the southern side of the central Pyrenean region, near roads running through the Cinca valley, which may have propitiated fluvial communication with the river Ebro, and through the *Somontano,* in particular between *Tarraco* and *Caesar Augusta* passing through *Ilerda* and *Osca*. It was founded in the middle of the first century B.C. and abandoned towards the late second or early third century A.D. Its public buildings underwent a remarkable monumentalization process in the second half of the first century A.D.

The excavations carried out by the Departamento de Ciencias de la Antigüedad of the University of Zaragoza and the Institut Ausonius of the University Michel Montaigne of Bordeaux from 1991 onwards have brought to light various buildings in the forum, in particular the Curia, where a series of pedestals are preserved *in situ* as prime epigraphic testimonies for the knowledge of municipal elites, two bath areas and the remains of some private dwellings.

This paper focuses on the geological identification of the ornamental rocks used in the Curia (engraved pedestals) and in the bath complex I (revetment panels and paving). Analyses conducted reveal the exclusive use of Hispanian limestone, especially the so-called Santa Tecla limestone (Tarragona) and of limestone extracted near the site, whose quarries are also located and studied. Other questions regarding decoration of the baths and in particular the cost of pedestals shall also be tackled based on similar instances in other parts of the Roman world. The ultimate goal is to contribute fresh data to the identification, use and distribution of Hispanian limestone, and to social and economic factors associated with these materials.

GRAINAUTLINE - A SUPERVISED GRAIN BOUNDARY EXTRACTION TOOL SUPPORTED BY IMAGE PROCESSING AND PATTERN RECOGNITION

Kristóf CSORBA,[1] Lilla BARANCSUK,[1]
Balázs SZÉKELY,[2] Judit ZÖLDFÖLDI[3]

[1]Department of Automation and Applied Informatics, Budapest University of Technology and Economics, Budapest, Hungary (csorba.kristof@aut.bme.hu; barancsuklilla@gmail.com)
[2]Department of Geophysics and Space Sciences, Eötvös Loránd University, Budapest, Hungary (balazs.szekely@ttk.elte.hu)
[3]Institute of Material Science, University Stuttgart, Stuttgart, Germany (zoeldfoeldi@yahoo.de)

Keywords: thin section, grain boundary, image processing

Extracting the grain boundaries from marble thin sections is an important starting point for many material analysis applications. It is used for example to calculate the maximum grain sizes which has a long tradition in marble provenencing. Earlier, MGS was estimated with the naked eye, later, thin sections were used. After these, more sophisticated procedures came into application like the measurement of Sr isotopes. The nowadays used software methods for automatically drawing the grains are unable to recognize the calcite grains in the marble thin section because of the characteristic appearance of the calcite twinnings. This is why a common approach is the manual drawing of the grain borders, which is a very time consuming procedure. In cases involving many samples, it becomes even unsuitable.

GrainAutLine is a software designed for the automation of thin section processing using state-of-the-art image processing and pattern recognition technologies. It is a drawing application designed for drawing grain boundaries on a thin section image in a semi-automated way. It was designed with a strong emphasis on user-supervised operations: every step performed by the automatic tools can be checked and modified by the user, before it is finalized. This ensures a high quality output even if the software does not precisely recognize all boundaries.

After an initial border extraction, simple drawing tools allow the user to add or remove lines. After every step, connected component analysis is

performed. This method may spare a lot of editing work for the user, e.g. if a grain is separated into two parts by an unnecessary line, it is enough to remove a small part of the separating line; the rest is done automatically. As soon as the two areas are connected, they are merged into a single grain; the remaining pieces of the line are removed automatically.
Twin crystal tools search for grains having thin, parallel borders to identify the borders caused by twin crystals. These borders can be removed automatically from the entire image with a single keystroke. If multiple grains got merged as the border between them was not detected correctly, automatic partitioning can help very quickly: the program searches for narrow passages between larger areas and fills them automatically.
Once the grain borders are finished, GrainAutLine has functions to extract several statistics like grain size histograms, color histograms, and shape properties to be used for further analysis.

FIRST REMARKS ABOUT THE PAVEMENT OF THE NEWLY DISCOVERED MITHRAEUM OF MULTICOLOURED MARBLES AT OSTIA AND NEW INVESTIGATIONS ON ROMAN AND LATE ROMAN WHITE AND COLOURED MARBLES FROM BLOCK IV, IX

Massimiliano DAVID,[1] Stefano SUCCI,[2] Marcello TURCI[3]

[1]Dipartimento di Storia Culture Civiltà, Sezione archeologia, Università di Bologna, Ravenna, Italy (massimiliano.david@unibo.it)
[2]Ostia Marina Project, Rimini, Italy (marcello.turci@gmail.com)
[3]Ostia Marina Project, Rome, Italy (iccus@hotmail.it)

Keywords: Ostia marina project, the so-called mithraeum of multicoloured marbles, analytical investigations

This paper intends to focus on the latest research carried out about the marble fragments found during the archaeological investigations conducted since 2007 by the University of Bologna (Dipartimento di Storia, Culture, Civiltà. Sezione Archeologia), in collaboration with the Soprintendenza speciale per i Beni Archeologici di Roma, within the Ostia Marina Project in the suburban area of Ostia (block IV, IX), as continuation, deepening and updating of the contribution presented at the X International Asmosia Conference held in Rome in 2012.
The investigations continued fruitfully over the years and led to a further expansion of the excavated area, with the addition to the thermal complex of Silenus (sector A) of new structures from the sector B, among which stands out the significant discovery of a new mithraeum of multicoloured marbles. The mithraeum still preserves the nearly intact pavement made of reused multicoloured marbles. A technical and archaeological investigation of the pavement is presented, as well as the results of the quantitative and qualitative analysis of the marbles.
In addition to these results, the analysis of the finest marble finds coming from all over the excavation area is presented - the new findings added to those of previous campaigns reach the number of about 6,000 units - with emphasis on architectural orders, covering and decorative elements coming from the thermal complex of Silenus. These investigations suggest a study on late Roman reused marble findings (mithraeum and thermal complex), and on post-ancient despoliation of the block IV, IX.

THE RE-USE OF MONOLITHIC COLUMNS IN THE INVENTION AND PERSISTENCE OF ROMAN ARCHITECTURE

Peter D. DE STAEBLER

Pratt Institute, School of Architecture, Graduate Center for Planning, Brooklyn, New York, United States (peter.destaebler@nyu.edu)

Keywords: monolithic, spolia, Republican, early Christian, late Roman, Aphrodisias, Florence

Monolithic columns are a hallmark of the so-called "marble-style" architecture of the imperial Roman period. Each shaft represents a tremendous expenditure of effort and money to quarry, transport, and install. Over time, columns were manufactured in an increasingly standardized range of sizes in order to facilitate their incorporation into grand civic and religious projects. Many columns were sponsored by the emperors and flowed toward Rome or were destined for favored projects in the provinces; many were locally produced as well. After the 3rd century CE, these columns were created in ever smaller numbers, and new late Roman and early Christian buildings primarily recycled precious monolithic columns from among the stock carved in prior centuries.

In this paper, I will focus on how monolithic columns played a central role in the formation of a distinctive Roman architecture in the periods when they were not widely produced. First is the forgotten detail that the earliest monolithic columns used in Rome during the Republican period arrived as spoils of war—as literal *spolia*—taken along with art, cash, weapons, and slaves from cities in the Hellenistic east. The columns were pre-made, with set dimensions, and removed from other structures, not ordered in specific sizes and numbers for defined projects. From the beginning, architects in Rome found ways to integrate these impressive blocks into their architectural schemes, and even, I suggest, to invent new building types (such as the columnar *scaenae frons*) in order to accommodate the vast number of columns on hand.

Second, I will investigate the revival in the late Roman period of this idea of centering the plan of a new building around an accumulated set of

monolithic columns. My initial research indicates that this is the case for many of the Constantinian and later churches in Rome and at least three church buildings at Aphrodisias in Caria, where key dimensions in the new buildings derive directly from existing dimensions of re-used monolithic columns. Remarkable is the long persistence and wide spread of this habit, which I suggest extends as far as the planning of the 11th-century Florentine baptistery.

STONES OF GALERIUS' VILLA OF *FELIX ROMULIANA* (GAMZIGRAD, SERBIA)

Bojan DJURIĆ,[1] Divna JOVANOVIĆ,[2] Stefan POP LAZIĆ,[3] Walter PROCHASKA[4]

[1]Department of Archaeology, University of Ljubljana, Ljubljana, Slovenia (bojandjuric@ff.uni-lj.si)
[2]Department of Mineralogy and Petrology, Geological Survey of Serbia, Belgrade, Serbia (djdivna@gmail.com)
[3]Archaeological Institute, Belgrade, Serbia (stefanpo@gmail.com)
[4]Department of Applied Geological Sciences and Geophysics, University of Leoben, Leoben, Austria (walter.prochaska@unileoben.ac.at)

Keywords: Imperial palace, ramparts, local and regional rocks, andesite, tuffite sandstone, limestone, Mediterranean white and coloured marbles, dressing stone, architectural elements, opus sectile

The fortified palace of *Gaius Galerius Valerius Maximianus Augustus*, named *Felix Romuliana* after his mother, was built between AD 298 and 306 in a secluded area along the Timok (*Timacum*) River near the modern village of Gamzigrad, in eastern Serbia. Archaeological research has been conducted there from 1953 onwards and revealed the remains of two residential buildings, three temples, baths and other structures enclosed within a double rampart with towers. East of the palace, on the hill of Magura, rest the remains of two mausolea (presumably for Galerius and his mother) associated with two tumuli. Nearby, there are also the remains of a tetrapylon erected over a crossroads.

For the construction of the ramparts, walls and substructures of different architectures inside and outside the palace, the builders extensively used local and to some extent regional rock material, but also bricks. The local material was hornblende andesite, quarried at the exterior NW corner of the palace, and silty-marly limestone, quarried on the hill of Magura. Magura was also the location where blocks of tuffitic sandstone, used in almost all structures, were quarried. The regional material used extensively in the ramparts and in almost all other architectures was whitish Sarmatian limestone from the area north of the Timok and Danube confluence. North of Gamzigrad, near the town of Rgotina, we identified the quarry of the brownish quartz sandstone used for the construction of the tetrapylon.

Imported Mediterranean marbles were used for architectural elements, mainly columns (pink granite, marmor Troadense, marmor Thessalicum, white Proconessos, Pentelicon and Thassos marbles) and *opus sectile* floors and walls of some of the rooms in the palace (red porphyry, rosso antico, porfido serpentino antico, cipollino verde, verde antico, pavonazzetto, breccia corallina, giallo antico, greco scritto, breccia policroma della Vittoria).

THE BUDAKALÁSZ TRAVERTINE PRODUCTION IN *PANNONIA INFERIOR* AND *MOESIA SUPERIOR*

Bojan DJURIĆ,[1] Sándor KELE,[2] Igor RIŽNAR[3]

[1]Department of Archaeology, University of Ljubljana, Ljubljana, Slovenia (bojandjuric@ff.uni-lj.si)
[2]Institute for Geological and Geochemical Research, Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Sciences, Budapest, Hungary (keles@geochem.hu)
[3]G. E. Geološke Ekspertize, Ljubljana, Slovenia (igor.riznar@telemach.net)

Keywords: Pannonian travertine, Budakalasz quarry, Danube transport, stone products, sarcophagi, altars, stelae, architectural elements, dressing stone, sculpture

The most commonly used building and ornamental material in Roman times in the area between the Alps and the Carpathians (provinces of *Pannonia sup*. and *inf*., *Moesia sup*.), was Neogene (Badenian and Sarmatian) limestones, which abound in the area. Their quarries were in most cases local (Duplek near Maribor for *Poetovio*, Vrapče near Zagreb for *Andautonia*, Tašmajdan in Belgrade for *Singidunum*), and some were regional (Dardagani near Zvornik for *Sirmium*). Apart from the Neogene limestones, all Roman centres along the Danube, from Budapest (*Aquincum*) in the N to Kostolac (*Viminacium*) in the SE, also revealed various and numerous products made of travertine. This rock was most often used to make sarcophagi (mostly 3rd cent.), altars and stelae (from 1st to 3rd cent.), but also aediculae, the southernmost piece of which was found in *Mursa* (Osijek). There, travertine was also used to build the bridge over the Drava River, as well as a colonnade along the main road entering the town from the E.
Several objects of travertine were selected to be analysed for δ^{13} C and δ^{18}O using Finnigan delta plus XP mass spectrometer. The results revealed the Budakalász (Buda Mts., Hungary) as the provenance of the stone, which is a Pleistocene thermogene fresh water limestone, the formation of which is presumably associated with late activity of the Miocene volcanism.
The Budakalász (and nearby Gellért Hill) travertine was used extensively in Aquincum (Budapest) from the 1st century onwards. Almost from the beginning of production, its products are present quite far south (e.g. *Mursa,* Osijek; *Sirmium*, Sremska Mitrovica), heralding the strong interprovincial trade in travertine products of the 2nd and 3rd centuries. In both *Panno-*

nia and *Moesia sup*., the production and trade in the Budakalász travertine corresponds with the trade network of products made of Eastern Alpine marbles. These two productions shared not only the same markets, but also a large portion of their iconographic models and technical skills.

GEOLOGICAL PROVENANCE OF ROMAN BUILDING AND ORNAMENTAL STONES WITHIN THE CIVITAS TUNGRORUM (EASTERN BELGIUM)

Roland DREESEN,[1] Catherine COQUELET,[2] Eric GOEMAERE,[1] Guido CREEMERS,[3] Geert VYNCKIER,[4] Alain VANDERHOEVEN[4]

[1]Geological Survey of Belgium, Brussels, Belgium
(roland.dreesen@naturalsciences.be; eric.goemaere@naturalsciences.be)
[2]Faculté de Philosophie, Arts et Lettres, Archéologie, Université Catholique de Louvain, Louvain-la-Neuve, Belgium (catherine.coquelet@uclouvain.be)
[3]Gallo-Roman Museum, Tongeren, Belgium (guido.creemers@limburg.be)
[4]Flemish Heritage Institute, Brussels, Belgium
(geert.vynckier@rwo.vlaanderen.be; alain.vanderhoeven@rwo.vlaanderen.be)

Keywords: Provenance, Roman building and ornamental stones, Belgium

The Romans used a broad spectrum of natural stones for building and decoration purposes both in the capital and in the agglomerations of the *Civitas Tungrorum* (province of *Germania Inferior*). Important amounts of sedimentary rocks have been used as "common" building stones including Holocene calcareous tufa, Cretaceous flints, Jurassic and Lower Carboniferous limestones and Upper-Carboniferous sandstones, all quarried nearby. Moreover, Pleistocene volcanic tuffs have been imported from the Eifel area in Germany. Various white or cream-colored Jurassic limestones (Norroy, Chémery, Euville) have been quarried in and shipped from the Lorraine area (N-France) for more prestigious architectonic elements (public and funerary monuments), most probably as a local substitute for the beloved white crystalline Mediterranean marbles. Their geological provenance has now been corroborated by comparative petrographical analysis. Moreover, their geographical distribution within the *Civitas* and adjacent provinces reflects potential fluvial transport routes (Meuse and Moselle-Rhine rivers). Otherwise, for the decoration of important public buildings (e.g. temples) and private houses, a combination of local, regional and more remote luxurious colored natural stones has been used. Black, grey and red Belgian sedimentary "marbles" (Upper Devonian and Lower Carboniferous limestones) occur besides dark-grey Visean limestones and red micaceous Famennian arkosic sandstones, all quarried within the *Civitas*.

Fine-grained cream-colored limestones have been imported from adjacent Roman provinces (e.g. Pierre de Caen, Lutetian limestone). Finally, small pieces of polychrome marbles (macroscopically identified as Rosso antico, Pavonazzetto, Granito verde a erbeta, Giallo antico, Fior di Pesco, Breccia corallina, etc.) have a rather Mediterranean provenance. All these colored stones have been applied as *opus sectile* elements in wall and floor decorations. Different types of natural stones have thus been used according to the function and importance/prestige of the construction. Their occurrence and distribution within the Civitas could point to their use as a romanisation tool. The unexpected occurrence of luxurious marbles would also indicate the importance or prestige of the Roman settlements at the northern border of the Roman Empire. The *Civitas* was a consumer of Mediterranean marbles before becoming itself a producer of imitation stones. The opening of quarries on its territory and the implementation of its natural resources, emphasize the evolution of economic relationships at the scale of the Northern Gaul provinces.

PRELIMINARY INVESTIGATION INTO THE STONE MATERIALS FROM NEA PAPHOS (CYPRUS)

Michalina DZWONIAREK

Institute of Geology, Adam Mickiewicz University in Poznań, Poznań, Poland
(michdzw@amu.edu.pl)

Keywords: biocalcarenites, Cyprus, marble

Nea Paphos (Kato Paphos) is located in the south western part of Cyprus. In the Hellenistic-Roman period it was one of the main towns on the island. Despite the clear importance of the city in Antiquity, Cyprus is still a dark stain on our knowledge about the network of the stone economy in the ancient world. These studies are aimed at supplementing this. A large amount of stone material on the site, as well as the development of trade in the period of greatest prosperity of the town, has provoked a detailed study of the deployed stone material. Stone in Paphos was used both as a building (walls and building structures), decorative (pavements, mosaics, capitals), and utilitarian material (mortaria, querns). Underground tombs (Tombs of Kings) had also been carved in limestone basement.

This presentation will discuss the preliminary study of used and provenance of limestones and marbles, based on petrographic study on thin section, XRD investigation, SEM-EDS morphological, micro-chemical analysis and also stable isotopes analysis.

The local biocalcarenites seem to have been used as the primary building material. Elements made from this material, within the site take a similar form and degree of damage (a significant degree of secondary porosity and the presence of carbonate-clayey cement in this limestones), which leads to a reduction of strength parameters of building and decorative value of stone. A preliminary study had already showed that the raw materials are of local provenance (Fabrica hill).

On site preserved were also elements of various types not present in Cyprus marble, mainly from Villa of Theseus baths – imports from the area of ancient Greece (e.g., from white, gray and green varieties to the breccia coralline).

THE USE OF COLOURED MARBLE IN THE BASILICA AEMILIA IN ROME (ITALY)

Christine ERTEL

Vienna, Austria (ch.ertel@aon.at)

Keywords: Forum Romanum, Rome, coloured marble

The Basilica Aemilia at the Forum Romanum was investigated by a project of the German Archaeological Institute in Rome. The final report is still in work by the editorial group of the Institute. The author herself worked as an architect on the decoration and reconstruction of the building.

During the late Republican and early Imperial time the use of coloured marble became an instrument to show the wealth and power of Rome, which was now on its peak. The Porticus in front of the Basilica Aemilia was replaced after the big fire of 14 A. D. partly imitating the Basilica Iulia built by Caesar. Therefore, the architecture of the Porticus consisted of huge blocks of white marble. The real extent of the reported fires at the Forum Romanum is difficult to judge. Nevertheless, it seems possible that already the Caesarean building inaugurated in 34 A. D. had columns of Africano and Cipollino, which remained in the Augustan period.

Most beautiful and multi-coloured was the floor of the central hall, the so-called Aula. The room about 100 m long was divided into three naves. While the side aisles had a uniform floor of white and blue Bardiglio plates, the central nave comprised three multi-coloured squares. They consisted of concentric frames of Africano, Giallo antico, again Africano, Pavonazzetto and Porta Santa. In the centre of the square was a small square of brilliant Giallo Antico.

The original socle consisted of red Porta Santa-marble profiles. Multi-coloured plates covered the walls of the Aula. Some of them could be reconstructed with dimensions of 1.60 to 1.40 m. The south wall of the Aula bore rectangular plates of Pavonazzetto, Porta Santa and Cipollino. Marble profiles divided the decoration into two or three horizontal zones. One storeroom contained about 500 pieces of white and coloured marble profiles. We could also distinguish fragments from niches made by several coloured marbles. The results of our work are shown in a 3-D-reconstruction of the Aula.

RECYCLING OF MARBLE: APOLLONIA-ARSUF (ISRAEL) AS A CASE STUDY

Moshe FISCHER,[1] Yannis MANIATIS,[2] Dimitris TAMBAKOPOULOS[2]

[1]Institute of Archaeology, Tel Aviv University, Tel Aviv, Israel (fischer@post.tau.ac.il)
[2]Laboratory of Archaeometry, Institute of Nanoscience and Nanotechnology, NCSR "Demokritos", Attiki, Greece (y.maniatis@inn.demokritos.gr; dimitrist@ims.demokritos.gr)

Keywords: Use, reuse/recycling, provenance, marble

The site of Apollonia-Arsuf (Israel) is Persian-Hellenistic in origin but the main use and reuse of marble is dated to the Roman-Byzantine, Early Islamic and Crusader periods. Marble used in Antiquity imported to Ancient Palestine from various quarries spread all over the Mediterranean and beyond it. Marble decorated mainly Caesarea Maritima (the capital of the province) and Ascalon, both located on the Mediterranean coast but also Scythopolis (Beth Shean) in the Jordan Valley. Other sites were also dedicating part of their efforts in the use of marble at least for special projects. One of these sites was Apollonia-Arsuf, where the main use of marble could be dated to the Byzantine period and a massive re-and moreover, misuse have been attributed to the Crusader period. A provenance analysis with scientific techniques is planned for some of these items, which are the subject of our paper. Three techniques will be used: Electron Paramagnetic Resonance Spectroscopy, Stable Isotope Analysis and Optical Examination and Maximum Grain Size measurements.

What would we expect from the provenance analysis?

Since marble items from Apollonia could have come from or via Caesarea Maritima – the main marble supplier of the province – the results of the Apollonia samples would be compared with the data bank existing for Caesarea Maritima and other sites in the Southern Levant region. Another question would be the internal use/reuse of marble in terms of how Roman and Byzantine material is identified for the Crusader reuse in the site of Apollonia-Arsuf itself. This reuse is very intensive and destructive, so that sometimes, the original (artistic) trend is rather unrecognizable. Therefore, it seems quite difficult to identify the reuse by archaeological and stylistic examination; thus, the determination of the provenance of the marble of such items would provide more information about this

process. That would represent a further contribution to the identification of marble items and their origin in a geographical area with such a *longue durée* and a very intensive reuse of building and artistic materials.

THE ALTERATION OF THE TYRRHENIAN STONE USED IN THE ANCIENT FORTIFICATIONS IN SOUSSE (TUNISIA)

Mohamed GAIED,[1] Ameur YOUNES[2]

[1]Institut des Beaux arts Sousse, Sousse, Tunisia (gaiedmoh_gaied@yahoo.fr)
[2]Faculté des Sciences Humaines et Sociales Tunis, Tunis, Tunisia (ameuryounes@yahoo.fr)

Keywords: Rejiche Formation, Sousse, fortifications, alteration, analyses.

The town of Sousse is located in the central-east of Tunisia, about 145 km south of the capital Tunis. The modern town succeeds to the Libycum agglomeration *Hadrim*(?) and to the ancient town of *Hadrumetum*.
Under the Roman Empire, the city experienced a remarkable urban growth. Yet, during the Byzantine and Muslim periods the town built-up area declined drastically. The medieval *Ribat* and ramparts, built with medium and large-sized squared oolithic sandstones from Rejiche Formation, are among the best preserved monuments in the city. The *Ribat*, whose *substratum* dates back from the Byzantine period, was built at the end of the 8th century, but the ramparts were built in 859. The stone blocks employed in both monuments came from the Tyrrhenian dune line quarries located about 25 km far away. The ancient stone blocks, reused in the 8th-9th-century Muslim monuments, underwent serious alterations due to several factors such as humidity, salinity and the lithological nature of the stone.
Analyses concerning the emplacement of the blocks in the walls, water absorption and the freeze-thaw cycles will help us to determine the degree of alterability of this stone.
In the poster, we will show the plan of the two ancient monuments, the emplacement of weathered blocks and the results of the different analyses.

ESPEJÓN'S LIMESTONE (SORIA, SPAIN): QUARRYING, ARCHAEOMETRIC CHARACTERIZATION AND USES IN HISPANIA

Virginia GARCÍA-ENTERO,[1] Anna GUTIÉRREZ GARCIA-M.,[2] Sergio VIDAL ÁLVAREZ,[3] María J. PERÉX AGORRETA[4]

[1]Departamento Prehistoria y Arqueología, Universidad Nacional de Educación a Distancia (UNED), Madrid, Spain (vgarciaentero@geo.uned.es)
[2]Institut de Recherche sur les ArchéoMATériaux (IRAMAT), Université de Bordeaux Montaigne, Bordeaux, France (anna.gutierrez@u-bordeaux-montaigne.fr)
[3]Departamento de Antigüedades Medievales Museo Arqueológico Nacional (MAN) - Universidad Nacional de Educación a Distancia (UNED), Madrid, Spain (svidal@geo.uned.es)
[4]Departamento Historia Antigua, Universidad Nacional de Educación a Distancia (UNED), Madrid, Spain (mperex@geo.uned.es)

Keywords: Espejón limestone, quarries, archaeometric characterization

We present the first results of an ongoing research project entitled *Marmora Hispaniae. The Quarrying, Use and Trade of Espejón' Limestone in Roman and Late Antique Hispania*. Its main objective is to gain a deeper understanding of the quarrying, use, and distribution of this particular limestone in Roman Spain. Its results, contextualized in the framework of exploitation and uses of other Hispano-Roman stone resources, will add significant data on the whole picture of non-foreign *marmora* exploitation and use in the Iberian Peninsula.

Despite the information available is still somewhat limited, the work developed so far allows us to state that this limestone might have been the main ornamental stone in the Peninsular inland, leaving behind the initial idea of it being a secondary material linked almost exclusively to the nearby city of Clunia. Limestone from Espejón was highly valued due to its macroscopic appearance and lithological characteristics. As such, it was widely employed in Hispania from the Augustan era on, in the framework of new public ornamental programs of cities immersed in marbling processes (as evidenced by their presence in Segobriga's forum) as well as in meeting the needs of a Hispano-Roman elite that, from very early, emulates the ways of self-representation of imperial power, among which the massive

use of *marmora* had a prominent role. The employ of Espejón's limestone remained in full use throughout the Late Roman period, as part of interior decoration of key rural complexes such as Carranque (Toledo).

This project is intended to have a comprehensive approach. Thus, the archaeometric characterization of all existing lithological varieties as well as the identification of possible ancient extraction evidences are also a key part in it. The high variability of this Cretaceous stone, which presents at least five main types (a mainly yellow, quite homogeneous limestone; a brecciated yellow limestone; a brecciated red limestone; a red-yellow banded limestone; and a highly coloured conglomerate), makes it important to have a detailed macroscopic and microscopic description of them as reference for comparison with archaeological samples. This part is especially important as the Espejon limestone's chromatism makes it perfect for use as small *tessellae* for mosaics. Moreover, we undertook a survey of the territory of Espejón in order to obtain a picture as much complete as possible not only of the points of extraction (i.e. the quarries) but also to identify where and how the different varieties of Espejón limestone crop out as an important aspect to understand how the exploitation of this stone took place and was organized.

REUSE OF THE *MARMORA* FROM THE LATE ROMAN PALATIAL BUILDING AT CARRANQUE IN THE VISIGOTH NECROPOLIS

Virginia GARCÍA-ENTERO,[1] Anna GUTIÉRREZ GARCIA-M.,[2] Sergio VIDAL ÁLVAREZ,[3] Irene MAÑAS ROMERO[4]

[1]Departamento Prehistoria y Arqueología, Universidad Nacional de Educación a Distancia (UNED), Madrid, Spain (vgarciaentero@geo.uned.es)
[2]Institut de Recherche sur les ArchéoMATériaux (IRAMAT), Université de Bordeaux Montaigne, Bordeaux, France (anna.gutierrez@u-bordeaux-montaigne.fr)
[3]Departamento de Antigüedades Medievales Museo Arqueológico Nacional (MAN) - Universidad Nacional de Educación a Distancia (UNED), Madrid, Spain (svidal@geo.uned.es)
[4]Departamento Historia Antigua, Universidad Nacional de Educación a Distancia (UNED), Madrid, Spain (i.manas@geo.uned.es)

Keywords: Carranque, marmor reuse, Visigoth necropolis

The archaeological site of Carranque (Toledo, Spain) is one of the most important Hispano-Roman sites in terms of the use of *marmora* during the Late Roman Empire. The research carried out since 2004 in this site, has shed light on the extent of the use of more than forty types of *marmora* to decorate a prominent palatial building built in the late fourth century or early fifth century AD and which have been the subject of recent studies and publications: *porfido rosso, porfido nero, porfido verde egiziano, granito verde della sedia di San Lorenzo, granito bianco e nero, granito rosso* de Asuán, *granito verde a erbetta, serpentino, porfido vitelli, breccia verde di Sparta, rosso antico, cipollino rosso Taenarium, bigio morato/nero antico, verde antico, cipollino*, *fior di pesco, breccia di Sciro* o *di Settebassi, portasanta, marmor Thasium, marmor parium -lapis lychnites-, pavonazzetto, breccia corallina, africano, marmor carium* o *iassense, rosso brecciato, giallo Antico,* Estremoz marble, Almadén de la Plata marble, Espejón limestone, etc.

The study we present now focuses on the reuse of *marmora* from the Late Roman building in the construction of more than one hundred tombs in the necropolis developed in Visigothic times (sixth - seventh centuries AD). The excavation works carried out in 2009 and 2010 confirm the massive reuse of marbles to set up tombs. In fact, not only marble *crustae* and *opera sectilia* fragments; but also fragments of *opera sectilia*'s preparatory

beds were used again. Moreover, apart from the mere reuse of marble for the construction of the tombs, we have also detected the careful selection of certain pieces (*pavonazzetto* capitals of pilasters and a sarcophagus lid marble) that were incorporated into some graves' structure in an action that can be considered as spolia with symbolic meaning. The study of these materials entailed not only the specific identification and recording of each piece of *marmora*, which form a comprehensive database of the assemblage, but also a detailed examination of traces of use that could help in understanding the primary use of these fragments. Therefore, the results do not only help to deepen our understanding of the construction processes of the Visigothic cemetery, but also to get a more complete image of the volume of *marmora* originally used at the palatial building of Carranque.

THE MARBLE CAPITALS RE-USED IN THE CRYPT OF THE CATHEDRAL OF OTRANTO (LECCE, SOUTHERN ITALY): IDENTIFICATION AND DETERMINATION OF THE PROVENANCE

Maria Teresa GIANNOTTA,[1] Giovanni QUARTA,[1] Mauro BRILLI,[2] Francesca GIUSTINI,[2] Davide MELICA[1]

[1]IBAM-CNR, Institute for Archaeological and Monumental Heritage - National Research Council, Lecce, Italy (mariateresa.giannotta@cnr.it ; g.quarta@ibam.cnr.it; davide.melica@libero.it)
[2]IGAG-CNR, Institute of Environmental Geology and Geoengineering - National Research Council, Rome, Italy (mauro.brilli@igag.cnr.it; francesca.giustini@igag.cnr.it)

Keywords: Puglia, Italy, Otranto Cathedral, Roman and Byzantine Capitals, Spolia, White Marbles, Archaeometric Analyses

The modern town of Otranto (ancient *Hydruntum*) overlooks the Adriatic Sea from the southern coasts of the Apulian Peninsula in Southern Italy. In Antiquity, it was a Messapian settlement and a very important harbour, later a Roman municipium and then, in succession, a Byzantine, Gothic, Norman, Angevin and Aragonese centre. The modern town extends around the castle and the cathedral. This last monument, built in Norman times and consecrated in 1088, includes a crypt that predates the building and extends below the transept and the apse. Inside the cathedral, in the nave, the removal of the medieval mosaic for restoration, has allowed to bring to light a large polychrome mosaic belonging to an early Christian building that presented an elongated rectangular plan.

The large crypt is divided into forty five small spans by forty two ancient columns and forty three semi columns with marble capitals, most of which from older buildings (spolia). The capitals are a true collection of sculpture from the Roman Imperial age to the Romanesque one. We can distinguish two groups of re-used capitals. The first one (twenty specimens), dating to the second century A.D., includes lotus and acanthus capitals and Asiatic Corinthian capitals. The second group (around twenty specimens), dating to Late Antiquity and to the Byzantine Period, includes artefacts belonging to Corinthian capitals, 'Impost capitals' and 'Two-zone capitals'.

This study looks at the white re-used marble capitals (*spolia)* with the aim

of identifying the constituent marbles and the quarries from which the stone was extracted, using mineralogical-petrographic and isotopic analyses.
The capitals of the Imperial age are mostly made of Pentelic marble supporting the notion that the source of these materials was substantial and homogenous in the provenance monuments, probably located within the same *Hydruntum* or in the ancient and most important *Lupiae*. *The capitals of Byzantine period are made of Proconnesian marble coming from* Late Antiquity or Byzantine *monuments* of Otranto such as the early Christian building brought to light inside the Norman Cathedral.

THE IMPACT OF LOCAL GEOMORPHOLOGICAL AND GEOLOGICAL FEATURES OF THE AREA FOR THE CONSTRUCTION OF THE BURNUM AMPHITHEATRE

Miroslav GLAVIČIĆ,[1] Uroš STEPIŠNIK[2]

[1]Department of Archaeology, University of Zadar, Zadar, Croatia (glavicic@unizd.hr)
[2]Department of Geography, University of Ljubljana, Ljubljana, Slovenia
(uros.stepisnik@ff.uni-lj.si)

Keywords: Burnum, archaeology, amphitheatre, geology, geomorphology, the Krka River

After Bato's rebellion in Illyricum (AD 6-9) had ceased, the Romans built a legionary military camp (*castra*) Burnum. It was located on the right bank of the Krka River, on the opposite side of the Liburnian hillfort (*oppidum*) of *Burnistae,* in the vicinity of Puljane. Its function was to control and overlook the Krka River Canyon as well as the river crossings. In the first century, Burnum was the base of legions (*legiones*) and auxiliary units (*auxilia*), whose soldiers built a number of structures intended for military requirements (*castellum, amphitheatrum, campus, aquaductus*). In the vicinity of the camp, a civilian settlement (*canabae*) was established. On the NW outskirts of the military camp, an amphitheatre (*amphitheatrum*) and military training ground (*campus*) were built. Prior to their construction, the rocky karst surface was levelled and filled by a material which is abundant in small archaeological structures (parts of military equipment and weapons, and objects of daily use). Archaeological research (2003) surveyed the greater part of the amphitheatre. The architectural solutions that comply with the configuration of the relief were documented. For the construction of the amphitheatre a doline was utilised. Two main stages of construction of the amphitheatre were identified: the first from the early reign of Emperor *Claudius* and the other from the reign of Emperor Vespasian.

The whole area of Burnum campus is located on an extensive North Dalmatian corrosion plain, along the canyon of the Krka River. The plain in the wider area of the Burnum amphitheatre is built of Paleocene age carbonates. Among them prevails the thin layered limestone marl, limestone conglomerates and limestone breccia. Thicker layers of limestone are present only in rare isolated strata. In the Krka River canyon, which lies several

hundred meters south of the amphitheatre, are vast tufa dams. Analysis of the amphitheatre building material showed that limestone breccia is the prevailing material. External walls are built of thick layered limestone and travertine. Limestone breccia is the most common local material, which was probably obtained by cleaning the karren surface. Thick bedded limestone strata were identified several kilometres away. A quarry used in Antiquity was also identified there. Large amounts of tufa, which is present as a construction material in the amphitheatre and also plenty of other structures in the campus, were obtained from the nearby travertine waterfalls on the Krka River.

Constructions on a wider area of the Burnum military camp permanently changed the physical and cultural landscape. The interdisciplinary approach of archaeologists and geologists is to determine how geomorphological and geological characteristics of the area influenced the formation of the Burnum agglomeration and to detect changes in the physical and cultural landscape throughout history.

MARBLE SLABS USED AT THE ARCHAEOLOGICAL SITE OF SORNA NEAR POREČ ISTRIA – CROATIA

Đeni GOBIĆ-BRAVAR

Archaeological Museum of Istria, Pula, Croatia (geni.gobic.bravar@gmail.com)

Keywords: Use of marble, roman villa, restoration, identification

In the second half of the 20th century, the Istrian Peninsula saw tourism as a great economical income. At that time many touristic resorts like campsites and hotels were built. As the places chosen for the resorts had to be beautiful, they often coincided with old Roman ruins. For this purpose the Sorna Peninsula near Poreč was excavated from 1966 until 1968. Under the direction of archaeologist Štefan Mlakar a Roman villa was found. Many archaeological objects were excavated together with parts of architecture, fresco fragments and marble slabs.

Although the objects and the architecture parts were documented and researched from the archaeological point of view, the fresco fragments and the marble slabs did not share the same fate. It is sadly true that little attention has been given to marble, as part of the archaeological site, although it could add useful information to the understanding of a site and be presented to the public to show the beauty of the ancient Roman decorative taste. After finding the marble slabs from Sorna in a wooden box, forgotten first from the decadence moment of the villa and then from the moment of their archaeological retrieval, the author of the poster wished to study them and give them a possibility to be seen and admired again.

The marble slabs were only roughly washed so the first step was to clean them thoroughly and remove the incrustations, which were all of carbonate nature. The incrustations were removed by soaking them with ammonium bicarbonate and then mechanically with a scalpel. After drying, the surface of the slabs was treated with microcrystalline wax to give them a glimpse of the original shine and few pieces could be glued together.

The slabs were determined petrografically and then studied to define their possible use as wall or floor incrustations. Finally, a catalogue of slabs has been made.

THE USE OF ALCOVER STONE IN ROMAN TIMES (TARRACO, HISPANIA CITERIOR). CONTRIBUTIONS TO THE *OFFICINA LAPIDARIA TARRACONENSIS*.

Diana GOROSTIDI PI,[1,2] Jordi LÓPEZ VILAR,[1]
Anna GUTIÉRREZ GARCIA-M.[3]

[1]Institut Català d'Arqueologia Clàssica (ICAC), Tarragona, Spain
(dgorostidi@icac.cat; jlopez@icac.cat)
[2]Universitat Rovira i Virgili, Department of Catalan Philology,
Classics Area, Tarragona, Spain
[3]Institut de Recherche sur les ArchéoMATériaux (IRAMAT)
- Centre de Recherche en Physique Appliquée à l'Archéologie (CRP2A),
Université de Bordeaux Montaigne, Bordeaux, France (agutierrez@u-bordeaux3.fr)

Keywords: Tarraco, Pedra d'Alcover, Roman inscriptions

After the recent re-edition of Tarraco's epigraphic corpus (Alföldy, CIL II^2/14), we initiated a multidisciplinary project to study the stones used for the town's inscriptions (Gorostidi, López Vilar, in press). The first study on Santa Tecla's stone (Álvarez et alii, 2009) and the knowledge of the quarries of the territory of Tarragona (Gutiérrez Garcia-M. 2009) allows us to tackle the study of a material employed during the founding period of the town: Alcover Stone. Its lithology, very different from the bioclastic limestones and calcarenites so common around Tarragona that supplied large blocks and ashlars (El Mèdol stone and soldó stones), facilitates obtaining uniform, thin pieces perfect for plaques. Its use for the earliest epigraphy is one of the clearest evidences to date the first historic phases, since it was used in the honorific inscriptions dedicated to the foundation of the *colonia* in Caesar's times.

Alcover Stone was used alongside another local stone, Santa Tecla limestone, which was gradually implemented during Augustus' and Julio-Claudian times. However, in Flavian times, Alcover stone was no longer used in epigraphy. The detailed exam of the inscriptions enables the identification of a hierarchy on the use of all these stones; in this hierarchy, Alcover Stone is consigned to private uses from the Julio-Claudian period and gives way to the foreign, prestigious *marmora* and the already mentioned Santa Tecla stone.

Its complete disappearance in the epigraphic record coincides with a

change of technique of the *oficina lapidaria*. These workshops were from that period specialized in making a new kind of support which will become the most common in the town: the tripartite pedestals in Santa Tecla and Llisós stones. This typology was largely widespread on the whole *conventus Tarraconensis*, at the expense of the previously common plaques. This phenomenon occurred simultaneously with the important urbanistic changes that were undertaken on the upper part of the town in Flavian times.

THE MARBLE INVENTORY OF SAN SATURNINO/ CAGLIARI-SARDINIA

Silvana Maria GRILLO,[1] Walter PROCHASKA[2]

[1]Dipartimento di Geoingegneria e Tecnologie Ambientali, Facoltà di Ingegneria, Cagliari University, Cagliari, Italy (grillo@unica.it)
[2]Department of Applied Geological Sciences and Geophysics, University of Leoben, Leoben, Austria (walter.prochaska@unileoben.ac.at)

Keywords: marble provenance, weathering, salt-crystal growth

The San Saturnino Basilica of Cagliari was built in the fifth century AD and is situated in the place where, according to tradition, St. Saturnino was beheaded in 304 AD. The early Christian Basilica is considered one of the most significant in the Mediterranean. It is surrounded by an archaeological park, where some excavations have revealed several Roman and Byzantine tombs.

During the centuries, the Church underwent many restorations. In the late seventeenth century, the building was partly demolished to recover materials for the restoration of the Cagliari Cathedral. After substantial air-raid damage during the Second World War, extensive renovations and partial rebuilding were necessary. The new Church was not re-opened to the public until 1996.

The main construction materials of the church are different local limestones - Pietra Forte and Pietra Cantone - from several quarries in the region. The decorative architectural elements preserved basically are red, grey and white marble columns. The preliminary identification of these coloured marbles so far is Cipollino Rosso from Iasos /Asia Minor, and marbles from Lesbos and Carystum. Preliminary petrographic and geochemical studies showed that Carrara marble is the material of the white marble columns. Other fragments of white marbles, such as column bases, capitals and a sarcophagus, are presently being analyzed for their provenance.

Especially the white Carrara marble columns are in an extremely bad condition due to weathering and the crystallization of different salts, resulting in sugary corrosion and sanding of the columns.

Both, provenance studies of the marble inventory and investigations on the mechanism of the salt deterioration, will be presented.

DISCOVERY OF A LIMESTONE QUARRY IN NORTHERN CHORIA CONSIDIANA (PHRYGIA)

Hale GÜNEY

Department of History, İpek University, Ankara, Turkey (hguney@ipek.edu.tr)

Keywords: Choria Considiana, Mihalıççık, limestone quarry

The aim of this paper is to present the first results of an epigraphic survey research conducted in Mihalıççık County in Eskişehir, Turkey in 2014. Mihalıççık was on the regional borders of Phrygia, Bithynia and Galatia in Antiquity. Our survey in 2014 focused on a Roman necropolis which is around a limestone quarry near Dinek village in Mihalıççık. The area of discovery therefore is the northern part of Choria Considiana which was an imperial estate originally comprising a group of seven villages. This estate owned by a family of Italian origin lay in fertile country in north-east Phrygia. In the necropolis area, ten inscriptions have been found, two of which bear depictions of hammer, malleus and dolabra, presumably dated to the second century AD. The stone used for inscriptions seems to have been provided from the quarry here. However a provenance analysis (XRD, ICP-MS) that will be conducted in 2015 will further shed light on the exploitation of the quarry during the Roman Period. This research reveals an unknown stonemason community in Choria Considiana. Indeed, similar researches such as the one conducted in the local quarries in Colonia Germa in the southwest of Galatia show the importance of local quarries and stonemasonry in this region. This discovery therefore brings up many questions which need to be investigated: How was the quarry operated? How much does the stone used for the inscriptions found in the region reflect the stone from the quarry? What is the economic value of that quarry for the estate, Choria Considiana? What is the importance of stonemasonry in this region? The answers to these questions will definitely contribute to the understanding of the Roman rural economy in Asia Minor.

NEW INSIGHTS ON THE CHRONOLOGY, EXPLOITATION AND LIFE OF THE ROMAN QUARRY OF EL MÈDOL (TARRAGONA, SPAIN)

Anna GUTIÉRREZ GARCIA-M.,[1] Jordi LÓPEZ VILAR[2]

[1]Institut de Recherche sur les ArchéoMATériaux (IRAMAT) - Centre de Recherche en Physique Appliquée à l'Archéologie (CRP2A),
Université de Bordeaux Montaigne, Bordeaux, France
(anna.gutierrez@u-bordeaux-montaigne.fr)
[2]Institut Català d'Arqueologia Clàssica (ICAC), Tarragona, Spain (jlopez@icac.cat)

Keywords: quarry, El Mèdol, archaeological excavations

The Roman quarry of El Mèdol is the most important of all the quarries that mark out the territory of ancient *Tarraco* (modern Tarragona), and most of the stone used to monumentalize accordingly to its status as capital of the largest province in Roman Spain, *Hispania Tarraconensis*. Its importance has been well attested: it was officially declared *Monumento Artístico-Histórico* (1934), *Bien de Interés Nacional* (Heritage of National Interest) (1985), *Bien Cultural de Interés Nacional* (Cultural Heritage of National Interest) and part of the historical monuments of Tarragona that were declared World Heritage by UNESCO (2000).

El Mèdol is a deep, opencast, mainly pit-type quarry that exploited the local Miocenic biocalcarenite since Antiquity and also afterwards, until extraction permanently stopped in the mid-20th century.

During 2013, a comprehensive project of rehabilitation and renovation of its museographic layout was implemented under the auspices of ABERTIS, owner of the property, to protect its values and to promote its visit by the general public, as it stands next to a service area of the AP-7 highway, which receives 500,000 passengers per year. The project included the building of a new interpretation centre as well as the clearance of the vegetation, the detailed recording of the quarry fronts and the archaeological excavation of some specific areas of particular interest (a total number of 8 test-pits were carried out).

The results of all these works provided a really significant increase of our knowledge of this site as well as the phases of the building of *Tarraco*. Not only do we now have a comprehensive, detailed plan of all the quarry

fronts (including a new small area of extraction unknown until now), but also know that the volume of extraction at this site was in fact far larger than previously thought (from 66,000m^3 to *c.* 150,000m^3) and about the existence of large debris humps. Moreover, the archaeological excavations provided solid evidence (2 Roman coins and a C-14 date) to bring back the main period of extraction to the change of the era, instead of the Flavian period as assumed until now. Another important aspect is the discovering of what seems to be a point of control of the production at the entrance of the pit, and the remains of a possible Roman shrine.

NEW DATA ON THE USE AND DIFFUSION OF *BROCCATELLO DI SPAGNA*: NORTHERN SPAIN AND CENTRAL ITALY

Anna GUTIÉRREZ GARCIA-M.,[1] Isabel RODÀ,[2,3]
Diana GOROSTIDI PI[3,4]

[1]Institut de Recherche sur les ArchéoMATériaux (IRAMAT) - Centre de Recherche en Physique Appliquée à l'Archéologie (CRP2A),
Université de Bordeaux Montaigne, Bordeaux, France
(anna.gutierrez@u-bordeaux-montaigne.fr)
[2]Departamento De Ciències de l'Antiguitat, Universitat Autònoma de Barcelona (UAB);
(isabel.roda@uab.cat)
[3]Institut Català d'Arqueologia Clàssica (ICAC), Tarragona, Spain (dgorostidi@icac.cat)
[4]Universitat Rovira i Virgili (URV), Tarragona, Spain

Keywords: Broccatello di Spagna, distribution, Hispania, central Italy

During the last decades, our knowledge on the exploitation and use of ornamental stones (*marmora*), one of the natural resources somewhat overlooked in the archaeological research, has greatly increased thanks to several teams and projects that focused on these materials. Not only the location and study of the quarries where they were exploited, but also the examination of archaeological, sculptural and epigraphic assemblages as well as the re-study of old collections, all allow us to understand how they were exploited, the purposes they were intended for, the volume of extraction and even the trade or distribution routes.

Among them, *broccatello di Spagna* (locally known as Jaspi de la Cinta) stands out as an especially significant coloured Spanish stone in the context of Roman Spain and provides the best example to illustrate the importance that some of these materials reached. The quarries that supplied this stone are well known and this yellow and purple limestone from *Dertosa* (modern Tortosa) has a practically unique appearance that facilitates its identification to the expert eye without need of archaeometric analysis.

After the distribution maps presented by Lazzarini (2004), which assembled all the data on the presence of *broccatello,* both in Hispania and other Mediterranean territories available up to 2002, new data has arisen which completes the picture of its use and distribution. This paper presents these advances which mainly concern those derived from an on-going project on the distribution of this *marmor* outside Hispania, but are also important in regards of the use of *broccatello* in the northern territories of the Iberian Peninsula (i.e. the modern Basque country) and the Ebro Valley.

NEW DATA ON SPANISH MARBLES: THE CASE OF *GALLAECIA* (NW SPAIN)

Anna GUTIÉRREZ GARCIA-M.,[1] Hernando ROYO PLUMED,[2] Silvia GONZÁLEZ SOUTELO[3]

[1]Institut de Recherche sur les ArchéoMATériaux (IRAMAT) - Centre de Recherche en Physique Appliquée à l'Archéologie (CRP2A), Université de Bordeaux Montaigne, Bordeaux, France (anna.gutierrez@u-bordeaux-montaigne.fr)
[2]Institut Català d'Arqueologia Clàssica (ICAC), Tarragona, Spain (hroyo@icac.cat)
[3]GEAAT. Universidad de Vigo (UVigo), Ourense, Spain (Silviatui2004@yahoo.es)

Keywords: Gallaecia, O Incio marble, provenance study

In spite of the great leap forward experienced in our understanding of marble and other ornamental stones use in Roman Spain, provenance studies are still quite uncommon in some territories of the Iberian Peninsula. This was the case of the northwesternmost part (modern Galicia), where no significant work had been done on this subject. Thus, in 2012 we compiled a catalogue of marble objects found in this territory, most of them currently in several museums and institutions, but many others reemployed in early medieval churches. Subsequently, a provenance study of some of them was undertaken. Our first aim was not only to determine which marbles reached an area as far from the Mediterranean Sea as *Gallaecia*, but to do so from an interdisciplinary perspective, to obtain the chronology of its presence as well as to understand the trade routes and other mechanisms of the economy and society that produced or enjoyed these objects. However, soon enough it became clear that local marbles played a significant role on the marble consumption in this territory, as some of these objects presented very particular features that neither matched the features of the main well-known Classical marbles, nor of those of the southern Spanish ones (i.e. Almadén de la Plata, Estremoz, Macael, Mijas…).

Therefore, to locate the source and to perform the archaeometric characterization of these marbles became another main goal. Among them, the local stone known as O Incio marble was the first one to be approached since its very particular appearance (it is a white/grey, fine-grained, banded marble) strongly suggested it was the raw material of some of the objects in study and that it had been in use until recently. Nevertheless, another group of

white, coarse-grained marbles remained unidentified and thus other marble outcrops on the territory were surveyed (areas of Mondoñedo, Sarria, O Caurel and Portomarín) to gather first-hand data and samples.
The work presented here is part of an ongoing project in which the use of multimethod analysis (POM, CL and IRMS for C-O isotopic determination) is applied to identify and adequately characterize the different outcropping marble varieties as the first and basic step to correctly differentiate from other Spanish or even Mediterranean marbles. The results so far, and even in this initial stage of the study, show a picture much more complex than anticipated: next to some foreign materials, both from other regions of Spain as well as the Central Mediterranean (Italy), O Incio marble was rather used in this territory but it was not the only local marble variety exploited by the Romans. The archaeometric study provides the essential basis for pursuing further research

THASIAN CONNECTIONS OVERSEAS: SCULPTURE IN THE CYRENE MUSEUM (LIBYA) MADE OF DOLOMITIC MARBLE FROM THASOS

John J. HERRMANN,[1] Donato ATTANASIO[2]

[1]Museum of Fine Arts, Boston, Dedham, Massachusetts, United States (jherrmannjr@gmail.com)
[2]Istituto di Struttura della Materia, Consiglio Nazionale delle Ricerche (ISM-CNR), Rome, Italy (donato.attanasio@ism.cnr.it)

Keywords: d13C/d18O isotopes, EPR, Muse, Velletri Athena, Torlonia-Hierapytna Kore, Athens, Rome

Sculptures in the Cyrene Sculpture Museum were the subject of a provenance study that made use of isotopic analysis, paramagnetic resonance spectroscopy (EPR), maximum grain size (MGS), and color. Over 200 sculptures were analyzed, and four proved to be coarse-grained dolomitic marble from the Cape Vathy area on Thasos.

Usually figural sculptures in Thasian marble discovered far from the northern Greek island are products of workshops based in those regions. The Thasian marble was essentially only raw material to be sculpted at its destination. In the case of the Thasian sculptures in the Cyrene museum, however, either the workmanship or the typology reveals a specific connection with northern Greece. The relatively simplified workmanship of two statues of goddesses in Cyrene can be closely paralleled in sculptures in Thasos and Thessaloniki. The sculptors must have been northern Greeks.

The other two Thasian marble sculptures in the Cyrene Museum are figure types that are often made of Thasian marble. A Muse of Hellenistic type from the House of Jason Magnus resembles one of the Muses in Thasian marble in the Capitoline Museum, Rome. Treatment of the drapery even suggests that the two statues were carved by the same workshop. A colossal head of Athena of the Velletri type in Cyrene is very similar in scale and workmanship to three examples of the Velletri Athena found in the neighborhood of Rome. There clearly was a fashion for using Thasian marble for figures of both Muses and Colossal Athenas of these types, and the presence of elegant examples far to the west in Rome and to the southeast

in Cyrene, suggests that the sophisticated sculptors of Athens were a connecting link between marble, typology, and markets. Sculptors apparently spread out from the cultural capital of mainland Greece, bringing a preference of Thasian marble with them for these special productions.

CALCITIC MARBLE FROM THASOS AT RAVENNA

John J. HERRMANN,[1] Robert H. TYKOT,[2] Annewies VAN DEN HOEK[3]

[1]Museum of Fine Arts, Boston, Dedham, Massachusetts, United States
(jherrmannjr@gmail.com)
[2]Department of Anthropology, University of South Florida, Tampa, Florida, United States
(rtykot@usf.edu)
[3]Harvard Divinity School, Cambridge, Massachusetts, United States
(ahoek@hds.harvard.edu)

Keywords: d13C/d18O isotopes, macroscopic identification, S. Vitale, pavement, ambo, sarcophagi

On a macroscopic basis F. W. Deichmann has declared that most of the marble used in Late Antique/Early Byzantine Ravenna comes from the Proconnesus. To a great extent this observation appears justified. Most marble architectural decoration (column shafts, bases, capitals, parapets), church furniture (pulpits, altars, reliquaries), and sarcophagi appear to be made of medium or coarse-grained, gray-striped, light gray marble that could well have come from the Proconnesian quarries. Stylistically, moreover, this architectural decoration has close parallels in Constantinople. Domination by Proconnesian marble at Ravenna, however, may not be as complete as it appears at first glance. There is considerable evidence of "substitute" marbles for Proconnesian in Late Antiquity. In several sites in central Italy and northern Greece, multi-method scientific testing of Late Antique architectural marbles has revealed the presence of not only Proconnesian marble but also macroscopically similar marble from the island of Thasos. Marble from both sources is slightly grayish white and tends to have coarse grain and long gray stripes.

Close macroscopic re-examination of marble objects in Ravenna suggests strongly that there as well calcitic marble from Thasos accompanied Proconnesian marble. In spite of the two stones' similarities, it is often possible to distinguish them on a macroscopic basis; Thasian usually has larger grain, and its markings are often softer and more rounded than those of Proconnesian. The most conspicuous examples of apparently Thasian marble are slabs in the pavement of the mid-sixth century church of San Vitale. The very coarse grain, color, and soft, rounded spots of several of these slabs can be closely matched in the quarries at Aliki.

The gentle gray color, soft streaks, and coarse-grain of various other slabs and sarcophagi elsewhere at Ravenna also suggest the presence of calcitic marble from Thasos. A program of sampling in Ravenna and laboratory analysis at the University of South Florida is underway to assess this macroscopic evidence.

MARBLE ON ROME'S SOUTHWESTERN FRONTIER: THAMUGADI AND LAMBAESIS

John J. HERRMANN,[1] Robert H. TYKOT,[2] Annewies VAN DEN HOEK[3]

[1]Museum of Fine Arts, Boston, Dedham, Massachusetts, United States
(jherrmannjr@gmail.com)
[2]Department of Anthropology, University of South Florida, Tampa, Florida, United States
(rtykot@usf.edu)
[3]Harvard Divinity School, Cambridge, Massachusetts, United States
(ahoek@hds.harvard.edu)

Keywords: d13C/d18O isotopes, X-Ray Flourescenhce, macroscopic identification, Mt. Filfila, Cap de Garde, Mt. Mahouna, Cape Vathy (Thasos). Architectural decoration, sculpture

Around the first quarter of the second century the Roman emperors founded the cities of Thamugadi (Timgad) and Lambaesis (Tazoult/Lambèse) only 24 km from one another as bases to control the Berber population of the Aurès Mountains in eastern Algeria. The Mediterranean coast lies ca. 200 km to the north, and the nearest source of high quality decorative stone is at Aïn Smara, 122 km to the north. Thamugadi and Lambaesis were largely built of limestone and sandstone of apparently local origin, but there is also a significant presence of marble and high-quality travertine from more distant quarries. A variety of architectural and sculptural artifacts were sampled to provide a cross-section of these sources. Isotopic analysis was supplemented by X-ray fluorescence of Mg and Mn, and measurement of maximum grain size. Macroscopic observation of the artifacts was also useful in resolving some ambiguous cases.

Most marble for architecture proved to be from Mt. Filfila on the coast directly to the north. Fine-grained white was the favorite lithotype, but other varieties also appear: dark gray, black-spotted, and brown-and-green streaked. Other quarries of eastern Algeria seem to have been rarely used. Onyx marble from Mt. Mahouna and the gray-streaked marble of Cap de Garde were found occasionally in pavements. Colored marble was imported from distant quarries in western Algeria; rose alabaster came from Aïn Tekbalet, and columns of *alabastro a pecorella* from Bou Hanifia. Two pieces of white Carrara marble were identified, and on a macroscopic basis, it was possible to identify quite a few colorful *crustae* imported for wall revetments and pavements from Tunisia, Greece, and Asia Minor.

In the realm of figure sculpture, several statues and statuettes of dolomitic marble from Thasos were identified. Statues and reliefs also were carved of white Filfila marble. It remains uncertain whether the marble of some statues is from Filfila or Asia Minor. One figure-decorated sarcophagus is of Filfila marble, while a garland sarcophagus may be Proconnesian marble. Onyx marble/travertine from the relatively nearby quarry at Aïn Smara was used for a clumsy statue of Ceres.

The overall picture is one of heavy dominance of Mt. Filfila with minor contributions from other regional quarries and from quarries much further afield. Thasos is particularly notable as a contributor of white marble for sculpture.

STONE OBJECTS FROM VINDOBONA (AUSTRIA) – PETROLOGICAL CHARACTERIZATION AND PROVENANCE OF LOCAL STONE IN A HISTORICO-ECONOMICAL SETTING

Barbara HODITS,[1] Michaela KRONBERGER,[2] Sophie INSULANDER,[3] Martin MOSSER,[4] Andreas ROHATSCH[1]

[1]Institut für Geotechnik, Ingenieurgeologie, Technische Universität Wien, Vienna, Austria (barbara.hodits@tuwien.ac.at; andreas.rohatsch@tuwien.ac.at)
[2]Wien Museum, Vienna, Austria (michaela.kronberger@wienmuseum.at)
[3]Institut für Kulturgeschichte der Antike, Österreichische Akademie der Wissenschaften, Vienna, Austria (Sophie.Insulander@oeaw.ac.at)
[4]Stadtarchäologie Wien, Vienna, Austria (martin.mosser@stadtarchaeologie.at)

Keywords: Pannonia, Vindobona, Roman time monuments

The interdisciplinary project 'Stone Monuments and Stone Quarrying in the Carnuntum – Vindobona Area' aims to acquire new knowledge about Roman economic and settlement history, art, quarrying and infrastructure through the integration and analysis of archaeological and geological data collections.

Preliminary macroscopic examination of about one third of approximately 350 Roman stone objects, including all types of artefacts from works of art to plain building materials, suggests that three quarrying areas were significant for the supply of stones to ancient Vienna.

Based on historical maps and airborne lasers scans, potential quarrying regions around the Roman city and legionary camp of Vindobona were selected and representative samples taken.

For the characterization and evaluation of the relevant Neogene rock types from parts of the Vienna and nearby Pannonian Basin, such as algal limestones, or conglomerates and breccias, their structural and textural properties, mineralogical and paleontological composition as well as petrophysical properties, were investigated.

Interim results have already been possible; some main quarrying areas of Vindobona have been located: near Baden in Lower Austria (dolomite breccias), in Vienna itself (Nussdorf – Badenian algal limestone, Atzgersdorf – Sarmatian coquinas and oolithes, and Unterlaa – Pannonian quartzaren-

ite). Additionally, the origin of several algal limestones from the Leithagebirge is likely.
A detailed type catalogue based on the collected rock-samples is envisaged. It will contain rock slabs, their respective scans, as well as laboratory parameters, such as macro- and microscopic examinations and geological profiles.
Evaluating these results from an archaeological point of view, the following conclusions can be made. It seems that as a first step after the installation of the Roman legionary garrison, the building material was quarried from the margin of the Alpine region, including the Vindobona vicinity. Moreover, algal limestones from the Leitha area played an important role as raw material for sculptured stone monuments, such as gravestones, altars, etc.
GIS-mapping of all known archaeological sites between Vindobona and Carnuntum, as well as the analysis of aerial photographs and airborne laser scans will hopefully pinpoint potential quarries and highlight their necessary infrastructure. Equally important is the consideration of possible transportation routes. Interactions with Carnuntum, the provincial capital of Pannonia superior, in terms of exchange of goods as well as cultural or artistic transfer, are exciting sets of issues.

USE AND PROVENANCE OF ROMAN MARBLE IN ST. GEORGEN/STYRIA/AUSTRIA

Eva Maria IGLER,[1] Walter PROCHASKA,[1] Eva STEIGBERGER[2]

[1]Department of Applied Geological Sciences and Geophysics, University of Leoben, Leoben, Austria (evemarymaurer@netscape.net; walter.prochaska@unileoben.ac.at)
[2]Landeskonservatorat für Steiermark, Graz, Austria (eva.steigberger@bda.at)

Keywords: Provenance of marble, rural cemetary, architectural elements, archaeometrical analyses, composition of fluid microinclusions, analyses of thin sections, statistical evaluation

The paper deals with the investigation of the marble inventory of a rural cemetery in St. Georgen near Judenburg, Austria. The site is known for Roman gravestones and inscriptions since the beginning of the 20th century. It consists of at least six so-called viridiaria, each surrounding the foundations of a grave. The cemetery is located facing a street, which connects rural settlements in the upper Mur-Valley and leads to the South of the province of Noricum and onwards toward Italy.

In order to determine the provenance of the marbles used for the architectural elements and unearthed artefacts in the area, archaeometrical analyses were performed. Besides the standard method of the analysis of the stable Isotopes (C- and O- isotopes) trace element composition and the composition of the fluid microinclusions in the marbles were performed. The data underwent a statistical evaluation and provenance analysis using our databank with approximately 2500 quarry samples of ancient marbles.

In general, the marbles in St. Georgen are white. However, a slightly greyish variety with a medium to coarse grainsize occurs. Accordingly, two clearly distinct groups of marbles can be observed.

The first group coincides with the local marbles, which outcrop on the slopes near the excavation site. Evidently, ancient mining for marble only sporadically occurred here in a smaller scale and no traces of ancient mining can be observed. The marble is white, coarse-grained and of good quality. One example of a reused Roman stone of this type is the altar plate of the church of St. Georgen.

The other type of marbles is medium to coarse-grained with an appreciable amount of silicates. The isotopic composition is characterized by very light

O-isotopes and characteristic trace element composition, and can very well be discriminated from the other group of local marbles used. This second type of marbles can clearly be correlated with a prominent group of marbles (Kraig marbles) from Carinthia in Southern Austria testifying marble trade in Roman times in this area over far distances.
The most important example of this marble was found in 1784. It is a plate of a Capricorn (sea-goat), most probably resembling the coat of arms of Augustan legions operating in the area.

NOTES ON EARLY CHRISTIAN AMBOS AND ALTARS IN THE LIGHT OF FRAGMENTARILY PRESERVED MONUMENTS FROM THE ISLANDS OF PAG AND RAB

Mirja JARAK

Archaeological Department, Faculty of Humanities and Social Sciences, Zagreb, Croatia
(mjarak@ffzg.hr)

Keywords: ambos, altars, Adriatic Basin

There are several reasons for the proposed theme of this article. Among different groups of early Christian sculpture from the territory of the Roman province of Dalmatia, findings of ambos, altars and ciboria (which are generally a separate group of church furniture in relation to the altar screens) exhibit many specific marks and represent a very complex field of study. Therefore, an analysis of unpublished or insufficiently described findings can contribute to the future synthesis. On the other hand, the proposed investigation includes discussion of the workshop origin of the chosen stone monuments, that is, questions regarding typology, decorative patterns and specification of stone. So, the important content of this conference, the use of marble and limestone in Antiquity, will be included in the paper.

The chosen monuments originate from the islands of Pag and Rab. Pag is the place of origin of smaller unpublished fragments of an ambo, which have been preserved in Novalja. The fragments are recognizable thanks to their form and preserved ornamentation. The Novalja ambo belongs to a very common type in Dalmatia – the type determined by rectangular slabs interconnected on inclined narrow sides. The preserved fragments have rich and specific decoration, which can serve for a detailed study of their workshop origin.

The second monument is partially preserved in the monastery of St. Andrew in the town of Rab. Based on a fragmentarily preserved slab with a nicely carved column on its lateral side, the monument could be recognized as an altar with a decorated frontal slab. As in the case of the Novalja ambo, the first insight into the possible workshop origin of the altar fragment from Rab, is reachable through the decorative patterns of the monument.

The author intends to discuss different approaches in investigation of workshop origin of the chosen monuments and possibilities of their application. The ornamental and stylistic data of the sculptured works have already been shown as strong indication of their workshop provenance. The morphological data are also widely discussed in literature. It is, however, legitimate to expect a detailed specification of stone used by known workshops.

THE MARBLE INVENTORY OF THE EARLY IMPERIAL SETTLEMENT OF THE MAGDALENSBERG IN CARYNTHIA/AUSTRIA

Heidi Maria KALTENBÖCK,[1] Walter PROCHASKA,[1]
Alexandra STEINER[2]

[1]Department of Applied Geological Sciences and Geophysics,
University of Leoben, Leoben, Austria
(heidi-maria.kaltenboeck@stud.unileoben.ac.at; walter.prochaska@unileoben.ac.at)
[2]Belghofergasse 35/5, Vienna, Austria (Steiner_Alex@gmx.at)

Keywords: marble provenance, Magdalensberg, Carrara marble

The settlement on Magdalensberg Mountain in Carinthia is located in the central region of Regnum Noricum and has a history of settlement of 70 up to 80 years. The intensified immigration of Roman merchants around the middle of the first century B.C.E., trade with mining products as well as the import of Roman goods, helped the settlement become a regional economic centre until the relatively rapid break-up in the 40s of the first century C.E. Despite the short period of settlement, a broad range of objects and types of finds made of stone and marble can be found throughout the excavation.

Since the first excavation in the middle of the 19th century, innumerable artefacts were unearthed on the Magdalensberg. The big architectural parts were possibly transferred to Virunum or to another place after the abandonment of the settlement. However smaller fragments and especially a big number of stele were available for archaeometric analysis to investigate the provenance of the marbles used. For this purpose we applied the analysis of the stable Isotopes (C- and O- isotopes), the trace element composition and the composition of the fluid microinclusions in the marbles. To investigate the provenance of the marbles, the data were statistically evaluated and compared with the analytical results of the marbles of our databank (approximately 2500 quarry samples of ancient marbles).

According to their macroscopic characteristics, the marbles of the Magdalensberg can be subdivided into 4 different groups: white fine-grained of very good quality, very fine-grained slightly greyish marbles, white coarse-grained and medium to coarse-grained.

Provenance analysis (isotope analysis, trace element analysis and the analysis of the inclusion fluids) show that the coarse- and medium grained marbles mainly gravestones etc., are alpine marbles from the Roman quarries of Gummern and Kraig, whereas the finer grained marbles originate from the quarries of Carrara (Carrara white and Bardigilio) testifying the trading relations with northern Italy after the integration of Noricum into the Roman Empire.

ROMAN LIMEKILN IN THE BAY OF SV. IVAN KORNETSKI NEAR UMAG, CROATIA

Joška Tea KATUNARIĆ KRIJAKOV

Academy of Arts, University of Split, Split, Croatia (teakatunaric@gmail.com)

Keywords: Roman limekiln, villa maritima, necropolis

In the Bay of Sv. Ivan Kornetski near Umag, Istria, the lower part of a Roman limekiln of cylindrical shape was discovered. It is one of the few Roman limekilns discovered in Croatia. The upper part of the kiln was totally destroyed by construction works. The diameter of the preserved part was 4.3 x 3.5 m, and the extant height of the structure comes to 2.62 m. The lower part of limekiln was carved in the bedrock and built of stone blocks. On top of this stone wall, were fragments of tegula and imbrex. On the northern side was an entry into a firebox enclosed by a wall 1.2 m long and 0.5 m wide. The fill of the kiln consisted of large lumps of stone, ash and soot. Inside the fill several fragments of burned imbrex, tegula and amphora were found.

West of the limekiln was the necropolis. Closest to the limekiln were two skeleton graves: G1 and G2. The deceased in the burial G1 was a man of about 45 to 50 who had been engaged in arduous manual labour during his lifetime. Two ceramic mugs were found above his shoulders. The grave also yielded a copper coin from the beginning of the principate of Augustus. The deceased in the burial G2 was a man aged between 50 and 55, a mason during his lifetime judging from the carver's stone chisel placed with him in the grave. He was poorly nourished and suffered from anaemia. In the right hand he held a bronze coin with a likeness of Faustina the Younger.

The limekiln and necropolis were used by the nearby luxury Roman villa maritima with accompanying baths. The earliest stratum of life in the area of the villa dates from the middle of the 2nd and through the 1st century BC. The construction of the villa baths is dated according to a coin of Augustus found in the wall between the caldarium and the tepidarium. The baths lost their original purpose in the 2nd and 3rd century and an oil mill was built in their place. A Late Antiquity necropolis is located in the southern part of the baths, among the ruined walls.

SARCOPHAGI OF ROMAN DALMATIA MATERIAL – PROVENANCE – WORKMANSHIP

Guntram KOCH

Christlich Archäologisches Seminar, Marburg, Germany (kochg@staff.uni-marburg.de)

Keywords: Dalmatia, Salona, Roman sarcophagi

Sarcophagi of Roman imperial times are preserved in large numbers. More than 16,000 are known (mostly in fragments). There were three centers of production, namely Rome, Athens and Docimium (Asia Minor), whose works were widely exported. In addition, in most of the provinces workshops were established, working for local demands. In Dalmatia, above all in the capital Salona, the find-situation is unusually rich, although that region had no available local marble, which was the preferred material for sarcophagi in the whole empire. We can find:

- Imports of marble sarcophagi with elaborate reliefs coming from the three centers, in different numbers.
- Locally made sarcophagi
  - from limestone;
  - from marble imported as roughly cut chests and lids;
  - from marble imported as half-finished objects.

The sarcophagi, which were executed in local workshops in Dalmatia, show either a decoration, which stands in the local tradition, or copied patterns from one of the three centers or even from other regions. In addition it is possible to recognize some sculptors who came from other regions to Dalmatia, that is Salona, and carved sarcophagi there.

The highly complex situation makes Dalmatia, in terms of sarcophagi of Roman imperial times, one of the most interesting provinces of the whole Roman Empire.

PROVENANCE ANALYSIS OF 'CALCITE-ALABASTER' VESSELS FROM QATNA, SYRIA, BY NAA

Tina KOESTER,[1] Ernst PERNICKA[2]

[1]Institute for Ancient Near Eastern Studies, University of Tuebingen, Tuebingen, Germany
(tina.koester@uni-tuebingen.de)
[2]Curt Engelhorn Zentrum Archaeometrie gGmbH, Mannheim, Germany
(ernst.pernicka@cez-archaeometrie.de)

Keywords: provenance analysis, calcite-alabaster, travertine

Vessels made from '*calcite-alabaster*' (also known as '*Egyptian Alabaster*' or '*travertine*') were a tangible part of exchange systems, which linked kingdoms of the Eastern Mediterranean to Mesopotamia in the 2nd millennium BC. It is widely assumed that those vessels, which were found in the Levant, mostly in elite Bronze Age context, were manufactured in Egyptian workshops. This assumption is mainly based on the production of typologically highly similar vessel forms in Egypt since the 4th millennium BC and on the antique exploitation of '*calcite-alabaster*' quarries in Egypt. However, a limited number of vessels discovered at Levantine sites have a Levantine form or display slight, but marked distinctions from the bulk of vessels known from Egypt itself. Since deposits of travertine are also known outside of Egypt, the archaeometric analysis of '*calcite alabaster*' vessels may clarify whether solely Egyptian raw material was used.

An initial result of this study was the development of a procedure to differentiate between '*calcite-alabaster*' deposits. This involved the application of neutron activation analysis (NAA) to determine the concentration of 25 trace elements, which were selected on geochemical reasoning. Furthermore, discriminating elements and element ratios were identified by principal component analysis and discriminant analysis, resulting in a multi-step interpretation procedure to differentiate between various deposits.

This routine was subsequently implemented to study the provenance of 68 '*calcite-alabaster*' vessels, discovered in two Bronze Age grave contexts at Qatna, Syria.

For the majority of the vessels studied, an Egyptian provenance of the raw material could not be excluded, but several vessels are distinguished by marked difference in trace element concentrations from the Egyptian sources. Interestingly, neither all of these anomalous vessels can be typologically classified as 'non-Egyptian', nor are they chemically homogenous. At the same time, not all typologically 'Levantine' vessels are chemically different from the Egyptian raw material. This demonstrates that the typology of a '*calcite-alabaster*' vessel cannot act as the sole criterion for the origin of the raw material. In the presented case, the chemically anomalous vessels indicate that Egypt was not the only source for 'calcite alabaster', but rather that deposits in other regions also need to be considered.

THE PENTELIC MARBLE OF THE CARNEGIE MUSEUM OF PITTSBURGH, PENNSYLVANIA U.S.A.

Albert D. KOLLAR

Geology and Invertebrate Paleontology, Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, United States (kollara@carnegiemnh.org)

Keywords: Pentelic, Carnegie, Sculpture

The Carnegie Museum in Pittsburgh, Pennsylvania is a complex of historic and architectural buildings that has received landmark status by the United States Department of the Interior and the Pittsburgh History and Landmarks Foundation. The integration of the Carnegie Library, Music Hall, Natural History Museum, and Museum of Art represents the first multi-use public institution in the United States. Funded by Andrew Carnegie, the American Steel Magnate, it was built in 1895 and expanded in 1907. The architects, Longfellow, Alden, & Harlow, incorporated 16 world famous building stones from Algeria, Croatia, France, Greece, Ireland, Italy, and the United States.

The Museum used many tons of the historic white Pentelic Marble from Mount Pentelikon, Greece in the construction of flooring, walls, doorways, and balcony in the neoclassical architecture of the Hall of Sculpture c. 1907. The hall architects were inspired by the Parthenon cella or inner sanctuary of the 5th century BCE Greek temple atop the Athenian Acropolis dedicated to the goddess Athena. The Hall is 126 feet long, 58 feet wide, and 46 feet high, with a total floor area of 7308 square feet. The natural sunlight glass ceiling is circled by a plaster frieze molded from the Parthenon exterior copied in 1898. The frieze depicts the ceremonial procession that open at the annual festival of Athena in the ancient Greek city. When the hall opened in 1907 large plaster casts of Egyptian, middle eastern, classical Greek and antique Roman statuary were placed on display on the first floor. Only eight Greek statuary are currently displayed on the balcony today. The remainder have been moved into the adjourning Architecture Hall where 15875 square feet of floor is covered in Pentelic Marble.

The curators and historians who have discussed the history of the Carnegie Architecture most often refer to the Pentelic Marble as the same marble from the same quarry that was used to construct the original Temple of

Athena in Athens. However, the specific historic record of the Carnegie Museum architects did not specify the exact provenance of the Pentelic Marble. Our objective is to sample the Pentelic floor marble in Sculpture Hall and Architecture Hall to be further analyzed in the lab to assess the isotopic value. Hopefully providing a resolution as to the appropriate intraquarry source.

THREE MARBLE BLOCKS WITH INSCRIPTIONS FROM THASSIAN AGORA - NEW STUDIES

Tony KOZELJ, Manuela WURCH-KOZELJ

[1]Ecole Française d'Athènes, Athens, Greece
(tonykozelj@hotmail.com; manuela_wk@hotmail.com)

Keywords: agora, altars, inscriptions, pilaster

The first marble block with the inscription was presented in 2003 (15-20 September), at the ASMOSIA VII conference on the island of Thassos, Greece. Due to disagreement amongst inscription specialists, the presentation was not published at the time of publishing the conference papers. However, this is an important marble block with an inscription about "regulation of the law on wine production and trade in the 5th century BC
The second marble block with inscription is also known and has been presented as the border stone of Zeus's temple in Thassian Agora. The new findings prove that the block is part of the altar, namely its left pilaster.
The third marble block represents part of the altar as well, and is also a left pilaster with the inscription "Apolon Lykiou", which was probably situated on the entrance "Passage des Theores", on the north-east side of Thassian Agora.

STONE MONUMENTS FROM CARNUNTUM AND SURROUNDING AREAS (AUSTRIA) – PETROLOGICAL CHARACTERIZATION AND QUARRY LOCATION IN A HISTORICAL CONTEXT

Gabrielle KREMER,[1] Beatrix MOSHAMMER,[2] Erich DRAGANITS,[3] Maria HEINRICH,[2] Isabella KITZ[1]

[1]Institut für Kulturgeschichte der Antike, Österreichische Akademie der Wissenschaften, Vienna, Austria (gabrielle.kremer@oeaw.ac.at; isabella.kitz@oeaw.ac.at)
[2]Geologische Bundesanstalt, Fachabteilung für Rohstoffgeologie, Vienna, Austria (Beatrix.Moshammer@geologie.ac.at; maria.heinrich@geologie.ac.at)
[3]Institut für Urgeschichte und Historische Archäologie, Universität Wien, Vienna, Austria (Erich.Draganits@univie.ac.at)

Keywords: Pannonia, Carnuntum, Roman time quarries

A great amount of Roman stone objects from Vindobona and Carnuntum are currently undergoing detailed petrological and litho-stratigraphic investigations by the project 'Stone Monuments and Stone Quarrying in the Carnuntum – Vindobona Area'.

The investigated material consists of approximately 2000 Roman stone objects from Carnuntum, the capital of the Roman province of Pannonia superior and legionary camp along the Danube Limes. A targeted selection, considering chronological, functional and archaeological criteria, has been made. A handheld microscope and a portable XRF analyser are applied for the non-destructive study of the stone objects. This gives additional information for the comparison of the stone objects and the samples from the quarries.

Local limestones and calcareous sandstones (Neogene, Middle to Upper Miocene 16–5 my) were mostly used for the major part of these monuments. These lithologies are widespread in the surroundings of Carnuntum, at the boundary of the Vienna Basin. By utilizing high resolution airborne laser scan topography, historical maps and fieldwork, remains of the natural occurrence of these rocks is sought in ancient quarries. Representative samples from the outcrops are investigated by thin-section microscopy, and their petrophysical and geochemical properties are analysed.

Preliminary results of this study include the location of some main quar-

rying areas for Carnuntum, between Bad Deutsch-Altenburg and Hundsheim, in the immediate neighbourhood of Carnuntum, as well as different algal limestones and calcareous arenites from the Leitha Mountains (Winden, Jois and Bruckneudorf) have also been located. In one of the quarries near Carnuntum the first evidence of a potential ancient extraction face has been found.

The combined evaluation of the geological and archaeological data, taking both the stone objects and the quarrying sites into consideration, will provide insight into the utilization of geological resources in the Carnuntum – Vindobona area. Based on this new view and on the archaeological research already undertaken on the stone monuments from Carnuntum, the development and evolution of local stonecutter workshops will be investigated. This allows for more general considerations regarding economic interactions, transport and the relationship between Carnuntum and its hinterland.

MILLSTONE QUARRIES OF THE SHAWANGUNK RIDGE, LOWER SILURIAN METACONGLOMERATE, NEW YORK, U.S.A.

Philip C. LaPORTA

The Center for the Investigation of Native and Ancient Quarries, Goshen, New York, United States/Department of Chemistry and Physical Sciences, Pace University, Pleasantville, New York, United States (plaporta@nativequarries.org; plaporta.cinaq@gmail.com)

Keywords: Millstones, millstone quarries, Shawangunk metaconglomerate

Millstone quarries have not yet been documented for the New York metropolitan area. More than 85% of all millstones recovered from historic archaeological sites in the New York region are fashioned from the Silurian Shawangunk metaconglomerate. Petrologically, the Shawangunk is a pure quartz-pebble conglomerate cemented by fine-grained quartz sand. A quartz-pebble conglomerate, however, is too friable to serve for millstone production. Therefore, the diagenesis of the original sediment is critically important in understanding the suitability of this ore target for millstone production.

The conglomerate was a molasse sequence deposited during Ordovician/Silurian Taconian orogeny along eastern North America. The conglomerates were deposited as bajada sequences, coalescing alluvial fans, directly over the weathered Ordovician Martinsburg Shale. The bajada sequence, in turn, was overlain by alternating coarsening and fining upward sequences of quartz pebbles and sand capped by argillic clays. The Lower Silurian is overlain by an incursion of transgressive, high-calcium limestones of lower supratidal origin.

Highly alkaline and metalliferous brines within the Martinsburg Shale were remobilized during subsequent tectonic deformations and permeated the lower Shawangunk conglomerates. The alkaline solutions etched quartz pebbles and sand, dissolving the silica to create siliceous acid (H_4SiO_4). Introduction of H_4SiO_4 into porous quartz-sand matrices resulted in the precipitation of silica cement; which strengthened the conglomerate. Tectonic differential stress dissolved silica along σ_1 (maximum stress axis) and reprecipitated it along σ_3 (least stress axis) to generate a foliation of elongated quartz grains. This process of dissolution-reprecipitation served to weld the

pebbles together along sediment-grain contacts. Thin-section petrography reveals sutured grains and pressure solution halos occurring throughout the metaconglomerate. The final sequence of silicification events includes the influx of alkaline brines, supersatured with silica, to the base of the limestone units, precipitating quartz crystals in molds and vacuoles left behind by invertebrate fauna.

In association with silicification, sulfides and native elements travelling within the brines were deposited in select locations, i.e. native gold was precipitated at the base of the conglomerate, near its interface with the Martinsburg shale. Silver was precipitated along clay surfaces within the finer sediment fractions of graded sequences occurring above the conglomerate. Lastly, copper sulfides (chalcopyrite), iron sulfides (pyrite), and zinc sulfides (sphalerite) were deposited within open-spaced master joints of metamorphosed sediments. The process results in the development of a durable, welded metaconglomerate which competed with the French buhrstone industry. However, difficulty in quarry extraction restricted the industry to the New York region.

GREY AND GREYISH BANDED MARBLES FROM THE ESTREMOZ ANTICLINE IN LUSITANIA

Pilar LAPUENTE,[1] Trinidad NOGALES-BASARRATE,[2]
Hernando ROYO PLUMED,[1,3] Mauro BRILLI[4]

[1]Petrology and Geochemistry, Earth Sciences Department, Zaragoza University, Pedro Cerbuna, Zaragoza, Spain (plapuent@unizar.es; hroyoplu@unizar.es)
[2]Consejería de Educación y Cultura, Mérida, Spain (trinidad.nogales@mecd.es)
[3]Institut Català d´Arqueologia Clàssica (ICAC), Tarragona, Spain (hroyo@icac.cat)
[4]Istituto di Geologia Ambientale e Geoingegneria, CNR, Area della Ricerca Roma1, Rome, Italy (mauro.brilli@igag.cnr.it)

Keywords: Grey marbles, Estremoz Anticline marbles, Portuguese quarries, archaeometry, provenance

This contribution addresses the characterization study of grey and greyish banded marbles from the Estremoz Anticline marble district, in *Lusitania*. The multi-method approach combining optical microscopy (OM), cathodoluminescence (CL) and stable C and O isotope analysis aims to discriminate them from other visually similar marbles.

The Estremoz Anticline is one of the Variscan macrostructures in the Ossa Morena Zone, a major geological unit of the Iberian Massif in the SW of *Hispania*. The metamorphic complex comprises a 300 m thick sequence of marbles and calc-schists with lenticular bodies of acid metavolcanites and metadolomites. Grey and dark grey marbles occur either in continuous levels at the top of the sequence or as lenses in the light-coloured unit showing alternating bands in white and grey.

The whole Roman *Lusitanian* province, including its capital *Augusta Emerita*, was supplied with local marbles from this district. Although Roman quarrying of both white and coloured marbles had to be carried out jointly, it is clear that the workshop artisans chose materials according to their use. They would preferably select white marble, not only for sculpture, as Pliny refers, but also for architectural elements using the polychrome types as part of the decorative programmes. However, grey marble was used mainly as architectural elements, where it would highlight the striking details of structures, as well as the epigraphic elements such as plates, pedestals and blocks.

The study of marble provenance used in *Augusta Emerita* has focused mainly on the statuary, given the transcendence not only of verifying the massive use of local material, but also in elucidating the importation of other classical marbles, which is logical since the provincial capital emulated Rome and should therefore stand out above other provincial towns. Conversely, the study of marble origin used in architectural material or in the epigraphic repertoire, has not until now been addressed in depth, except for an initial approach carried out two decades ago using petrographic methods. However, the current scenario related to provenance studies has changed. On the one hand, the existence of different focuses of extraction belonging to different administrative provinces, such as the marbles of Almadén de la Plata district, which show similarities in physical and compositional parameters, makes it difficult to ascertain the marble origin of Hispanic artefacts. And on the other, the possibility that materials from both districts were used beyond their local and regional scope, even outside Iberia since their white varieties have been attested in several Roman sites in the North of Africa, have led us to highly characterize the grey and greyish banded marbles.

THE WINGED VICTORY OF SAMOTHRACE: NEW DATAS ABOUT THE DIFFERENT MARBLES USED FOR THE MONUMENT FROM THE SANCTUARY OF THE GREAT GODS

Ludovic LAUGIER,[1] Philippe BLANC,[2] Annie BLANC[3]

[1]Musée du Louvre, département des Antiquités grecques, étrusques et romaines, Paris, France (ludovic.laugier@louvre.fr)
[2]Sorbonne Universités, UPMC, Paris, France (philippe.blanc@upmc.fr)
[3]Sorbonne Universités LAMOP, Paris, France (philippe.blanc64@sfr.fr)

Keywords: Victory of Samothrace, Parian marble, Rhodian marble

The Winged Victory of Samothrace, a masterpiece of Hellenistic art composed of a base in gray marble with pinkish-white veins and a statue made from several white marble blocks sculpted separately and assembled, has been entirely restored in 2013-2014. It has been previously thought that the monument might have been sculpted from Proconnesian or Pentelic marble, but today it is agreed that the Winged Victory is in Parian marble and the boat which serves as its base in Rhodian marble from Lartos. Fragments of the boat and a feather of the right wing of the Nike, housed in the museum of Samothrace, have been analyzed by Pr. Maniatis and published in ASMOSIA IX.

In 2013–14, as the monument was restored and at the request of the Louvre, the different marbles constituting the monument were analyzed. Fifteen samples were taken from the bottom of the attachment holes made during the nineteenth-century restorations, and from breaks in the marble; by this way, no fragments from the original surface of the work were removed. It was decided to test several blocks from the pedestal of the base, a block from the boat, as well as all the blocks of the statue. Complementary methods were used so that the different results could be compared and cross-checked: measurement of the maximum size of the marble grains (MGS), analyses of the stable isotopes of the marble, petrography, and cathodoluminescence.

The results confirmed that all the boat and its plinth were sculpted in Lartos marble from the island of Rhodes. The statue, on the other hand, is entirely in Parian marble. An interesting fact that emerged from these results

was that the blocks of the statue—the body, the wings, and the drapery—do not all come from the same quarries in Paros. We already knew that a feather of the Nike from the Samothrace museum analyzed by Professor Maniatis is in Lakkoi marble. We now have a more complete scope of results which provides clues for a better understanding of the monument fabrication.

REVISITING THE ORIGIN AND DESTINATION OF THE LATE ANTIQUE MARZAMEMI 'CHURCH WRECK' CARGO

Justin LEIDWANGER,[1] Scott H. PIKE,[2] Andrew J. DONNELLY[3]

[1]Department of Classics, Stanford University, Stanford, California, United States (jleidwa@stanford.edu)
[2]Deptartment of Environmental and Earth Sciences, Willamette University, Salem, Oregon, United States (spike@willamette.edu)
[3]Department of History, Loyola University Chicago, Chicago, Illinois, United States (adonnel@luc.edu)

Keywords: shipwreck, marble trade, late antiquity

Initially explored by pioneering underwater archaeologist Gerhard Kapitän in the 1960s, the famous "church wreck" at Marzamemi (Sicily)—with its cargo of prefabricated religious architectural elements—has long held a special place in discussions of the ancient stone transport and late antique exchange more broadly. Building on Kapitän's work, renewed investigations of the wreck since 2012 have aimed to shed light on the broader socioeconomic and historical circumstances surrounding the shipment. Together, the vessel and its cargo offer insight into the character and patterns of maritime connectivity between the divergent east and west Mediterranean worlds, and the possible roles of imperial agency and local patronage in the ambitious architectural programs across the 6th-century Mediterranean world. Fundamental to answering these and other questions are the identifications of the most likely origin and destination for the cargo. Stable isotope analysis of marble samples collected from the site now offers a window into the geographic range of resources available for such an architectural program and, by extension, clues to the organization of materials, labor, and sponsorship behind such a shipment. Analysis of contemporary churches and other structures that incorporate similar materials along with an examination of corresponding primary textual sources allows for a reassessment of the most plausible destination of this complex cargo. This study, in turn, opens new possibilities for interpreting the social and political world of 6th-century exchange and consumption, including the individuals and institutions involved, and a re-evaluation of the multifaceted relationship between Justinian and the recently acquired imperial lands during his program of renewal.

TRACING ALABASTER (GYPSUM OR ANHYDRITE) ARTWORK USING TRACE ELEMENTS ANALYSIS AND A MULTI-ISOTOPE APPROACH (SR, S, O)

Lise LEROUX,[1] Wolfram KLOPPMANN,[2] Philippe BROMBLET,[3] Catherine GUERROT,[2] Anthony H. COOPER,[4] Pierre-Yves LE POGAM,[5] Dominique VINGTAIN[6]

[1]CRC-LRMH, USR3224, Paris, France (lise.leroux@culture.gouv.fr)
[2]BRGM, Unité Traçage isotopique et Datation, Orléans, France (w.kloppmann@brgm.fr; c.guerrot@brgm.fr)
[3]CICRP, Marseille, France (Philippe.Bromblet@cicrp.fr)
[4]Nottingham, United Kingdom (tony.gypsum@googlemail.com)
[5]Musée du Louvre, Département des sculptures, Paris, France (Pierre-Yves.Le-Pogam@louvre.fr)
[6]Musée du Petit Palais, Avignon, France (Dominique.VINGTAIN@mairie-avignon.com)

Keywords: alabaster, provenance, isotopic analysis

Gypsum alabaster ($CaSO_4 \cdot 2H_2O$) and anhydrite alabaster ($CaSO_4$) have been used throughout history for artworks and as ornamental stone, due to their fine-grained texture and white colour. Until five years ago, the origin of the raw material was understudied: few studies used conventional mineralogical and chemical analyses with unconvincing results, or were restricted to local areas. Since 2010, a largest study was started, concerning several European quarries in France (Jura, Alps, Provence, Burgundy, Lorraine, Aquitaine, Paris area), Spain (Aragon and Catalonia), England (East Midlands/Nottingham region, Cumberland, N Yorkshire), Germany (Harz Mountain foreland). The first part of the study concerned about 30 samples from quarries and artworks for which the provenance of the raw material had been already suggested on the basis of stylistic or historical documentation. Mineralogical (XRD), chemical (ICP-AES) and isotopic (CF-IRMS and TIMS) analyses were carried out in the laboratory. Due to the rather homogeneous composition, the multi-isotope fingerprinting (sulphur, oxygen and strontium isotopes) proved to be the most suitable methodology. A second research program performed with the Louvre Museum, including artworks from the Petit Palais museum in Avignon and several regional collections and monuments, validates this methodology with more than 30 other samples. The multi-isotope fingerprinting is highly specific with a

strong intra-group homogeneity and strong inter-group contrasts. It enables to identify the origin of raw materials used for sculptures from the 12th to 16th century. Nowadays, the aim is to enlarge the database with isotope analyses of samples from known or suspected historical alabaster exploitations of Western Europe, and also to test other analyses, such as cathodoluminescence due to the rare earth elements contents of alabasters.

THE CAPITAL OF TRÓIA (PORTUGAL): THE GATEWAY TO THE UNDERSTANDING OF ARCHITECTURE, DECORATION AND MATERIALS IN THE SETTLEMENT OF TRÓIA DURING ANTIQUITY

Filomena LIMÃO,[1] Jorge CARVALHO,[2] José MIRÃO,[3,4] Luís LOPES,[4,5] Vítor LISBOA[6]

[1]Departamento de História da Arte, Faculdade de Ciências Sociais e Humanas, Universidade Nova de Lisboa, Avenida de Berna, Lisbon, Portugal (msglimao@hotmail.com)
[2]Empresa de Desenvolvimento Mineiro, SA. (EDM), Lisbon, Portugal (jorge.carvalho@edm.pt)
[3]Departamento de Geociências, Universidade de Évora, ECT, Évora, Portugal (jmirao@uevora.pt; lopes@uevora.pt)
[4]Centro Hércules Évora, Évora, Portugal
[5]Centro de Geofísica de Évora, Évora, Portugal
[6]Laboratório Nacional de Energia e Geologia, IP. (LNEG), Amadora, Portugal (vitor.lisboa@lneg.pt)

Keywords: *Composite Roman capital, Marble, Geochemistry*

Tróia is a sandy peninsula situated in the Southwestern Atlantic coast of Portugal, separated from the city of Setúbal (*Caetobriga*) in the mainland, by the river Sado. Since the 1 st c. CE, Tróia has been an important industrial settlement producing fish-salting goods sent to all parts of the Roman Empire. In the 4 th c. CE, an Early Christian Basilica in the vicinity of a *domus*, was built over a previous area covered by *cetariae*. Several transformations in the architecture of this place lead to the reutilization, in Late Antiquity, of a Roman composite marble capital in a step of the *domus* ladder. This capital remained forgotten for hundreds of years until the end of the 20 th c. when Art Historian, Justino Maciel, mentioned it and is now studied in this work. In spite of being a chief economic site in Antiquity we still ignore much about Tróia's urban planning, architecture and decoration. Although imprisoned in the step, it is possible to define the typology and to determine the approximate measures of Tróia Capital (TC). In a sandy place like Tróia with no stone available where did this marble capital come from and which building did it belong to? Does the marble come from Estremoz - Vila Viçosa (Portugal) quarries or from another place of the Roman Empire? As no similar capital was found in Tróia, the objectives of

our study are to determine the origin of the marble and the original place of TC in architecture.
Experimental procedures including petrographic, mineralogical and geochemical studies have been carried out. Major, trace and rare earth element (REE) geochemistry of the TC sample were measured by ICP-MS. These data were compared with geochemical data from Estremoz - Vila Viçosa (EVV) marbles analyzed by XRF (major elements) and ICP-MS (trace elements).
Major elements are not directly comparable due to different analytical methods, though there are significant differences, especially in the MgO estimate of TC sample (13%) and EVV marbles (average 0.5%). Samples were also compared for available trace elements Sr, Y, Zr, Ba and La, which allowed inferring considerations about the dolomitization process and terrigenous input.
TC sample shows broadly seawater-like REE normalized distribution, with high Y/Ho ratio, characteristic light REE depletion, negative Ce anomaly and slightly negative Eu anomaly.
The interpretation of the TC chemical composition indicates a marble with dolomitic trend showing a different composition from the analyzed EVV marbles, exploited nowadays in quarries.

QUARRIES OF THE KORČULA ARCHIPELAGO

Ivka LIPANOVIĆ,[1] Vinka MARINKOVIĆ[2]

[1]Private conservator-restorator, Split, Croatia (ivka.lipanovic@hotmail.com)
[2]Croatian Conservation Institute, Section for stone conservation, Split, Croatia
(vmarinkovic@h-r-z.hr)

Keywords: quarries, Korčula archipelago

The poster is intended to give a brief overview of the quarries of the island of Korčula. The quarries were used as early as Antiquity and exploitation of stone has been carried out to the present day. Zones of the quarries will be marked on the map of Korčula and the islands of the Korčula archipelago: Sutvara, Vrnik, Gubavac, Kamenjak and Planjak. This article presents photos of today's state of quarries as a result of the field survey in 2014. Emphasis is placed on the protection of inactive quarries and recognition of Korčula quarries as cultural treasures and tourism potential.

THE USE OF MARBLE AND LIMESTONE FOR GREEK INSCRIPTIONS IN ANCIENT DALMATIA AND A NEW DOCUMENT FROM VRANJIC MENTIONING ALEXANDER

Mario LOMBARDO,[1] Irena RADIĆ ROSSI,[2]

[1]Università del Salento, Dipartimento di Beni Culturali, Lecce, Italy (mario.lombardo@unisalento.it)
[2]Department of Archaeology, University of Zadar, Zadar, Croatia (irradic@unizd.hr)

Keywords: Greek limestone Inscriptions, Ancient Dalmatia, Vranjic, Alexander, Pharos

The works of Brunšmid and Rendić-Miočević, as well as the recent collection by Cobianchi, clearly show that ancient Greek cities of Dalmatia, unlike those of Magna Grecia and Sicily, which preferred bronze, normally chose the stone (marble or limestone) for their public inscriptions, such as the so-called *psephisma* of Lumbarda, from the island of Korčula, or the decree from Pharos dating 219/218 B.C. or the *senatus consultum* from Salona.

In this context, we should also include a scarcely preserved fragment of a Greek inscription from Vranjic near Solin, found in 2006, during the reconstruction of its southern waterfront. It was part of an object of uncertain dimensions and function, made in rudist limestone, probably of local origin. Together with many other architectural elements, votive and funerary monuments, the fragment was found in a secondary position, reused for the reinforcement of the Vranjic waterfront during the period of the Early Middle Ages.

It presents a Greek text with the left parts of 8 lines, whose paleography suggests a dating in the last decades of the 4th or the beginnings of the 3rd century B.C. Even if poorly preserved, it is possible to recognize some expressions which point to the vocabulary of religious and cultic practices, as well as a reference to the month *Plynterion* that figures in the calendar of a few Greek poleis among which Paros and its colonies of Thasos in the North Aegean Sea and Pharos, on the Dalmatian island of Hvar. The inscription, which could then come from the nearby Parian colony, also presents two incomplete names which seem to refer to an *Al]exandros* and perhaps to the feasts of the *Alex]andreia*, that are attested in the religious calendar of Thasos.

HISTORIC EXPLOITATION OF *MARMORA* IN THE OSUNA-ESTEPA QUARRIES (SEVILLE, SPAIN)

Isabel LÓPEZ GARCÍA,[1] José Manuel COMPAÑA PRIETO[2]

[1]Department of Archaeology and Medieval History, University of Malaga, Malaga, Spain (milopez@uma.es)
[2]X-ray Diffraction Service, University of Salamanca, Salamanca, Spain (jmcompana@usal.es)

Keywords: Ancient Stone Quarries

Just a few scientific works are available on the Ancient exploitation of quarries within the southwestern end of the Hispalense countryside. Specifically, we lack detailed studies of the *Vrso-Ostippo* carving center, whose series of military reliefs and funerary *munus* are archaeologically well known. The main aim of our research is the identification of the quarries in the area in which Ancient extraction and use evidences remain. Later, a petrographic study of the raw materials produced has been carried out by using polarising microscopy, complemented by X-ray powder diffraction (XRPD). The first step of our research was a comprehensive study of the cartographic information, geological reports and the archaeological charts available. This work suggested potential extraction in some areas of Osuna (Las Canteras and Cerro del Calvario) and Estepa (Los Canterones). These areas were subsequently visited and sampled. The samples were firstly observed under the stereomicroscope, revealing significant differences. Then, thin sections were made to study the microstructures, and XRPD analyses were carried out to better identify the carbonate phases present (i.e. calcite, dolomite or a mixture).

A range of micritic limestones and bioclastic sandstones, mostly Miocene, have been identified, with different uses as raw materials for ornamental and building purposes. As a result, our historic-archaeologic knowledge on the supply areas of the famous *ursaonense* workshop has been greatly improved. Furthermore, those data allow new hypotheses about the chronology of the quarries, exchange networks and commercial routes in this sector of the *Hispania Ulterior Baetica*.

THE USE OF LIMESTONE IN THE ROMAN PROVINCE OF *DALMATIA*

Edisa LOZIĆ,[1] Igor RIŽNAR[2]

[1]Ljubljana, Slovenia (edisalozic@gmail.com)
[2]G. E. Geološke Ekspertize, Ljubljana, Slovenia (igor.riznar@telemach.net)

Keywords: Roman, stonemasonry production, funerary monuments, Dalmatia, lithotype, limestone

The paper deals with the *mode of stonemasonry production of funerary monuments* formed in the region characterized by fragmented topography with (very) limited possibilities for water transport of the rock material.
The main objective is to lay down new interpretative framework of the stonemasonry production in the interior of the Roman province of Dalmatia (today's BiH, partially Croatia, western Serbia, Montenegro) from the 1st to the 3rd century AD. The coastal zone of the territory of the province of Dalmatia has been excluded from this analysis due to the possibilities of marine transport that enable different models of production.
The research was based on two complementary methodologies.
Firstly, the macroscopic petrographic analysis was conducted on 177 funerary monuments held at the National Museum of Bosnia and Herzegovina. This enabled us to establish five groups (lithotypes) of limestone that were used for stonemasonry production. Observed lithotypes were recognised as parts of (various) geological formations described in the geological map of the researched area revealing the distribution of particular lithotype in the area and thus tracing the provenance of the rock. These results have revealed localized patterns of stone use or local supply of material.
Secondly, the archaeological analysis of the monuments has been conducted: the form of the funerary monuments and their spatial distribution were defined.
The result of both approaches is a distinct micro-regional grouping of determined types and subtypes of the analysed products. It clearly shows that the stonemasonry production was defined by several *(small)* stonemasonry production centres corresponding to the fragmented topography of the interior territory of the province.

LARTIOS LITHOS OF RHODES ISLAND: SCIENTIFIC CHARACTERIZATION AND POSSIBLE USES AND EXPORTS

Yannis MANIATIS,[1] Dimitris TAMBAKOPOULOS,[1]
Eleni PAPAVASSILIOU,[2] Kalliopi BAIRAMI[2]

[1]Laboratory of Archaeometry, Institute of Nanoscience and Nanotechnology,
NCSR "Demokritos", Attiki, Greece
(y.maniatis@inn.demokritos.gr; d.tambakopoulos@inn.demokritos.gr)
[2]Ministry of Culture, Ephorate of Antiquities of Dodecanase, Rhodes, Greece
(elenpapavassiliou@gmail.com; kalliopibairami@yahoo.gr)

Keywords: Rhodes, Lartios, Characterization

A large number of architectural elements, bases, altars, and even statues from the Hellenistic to the Italian domination times (1947) on the island of Rhodes, Dodecanese, Greece are made in a dark grey/blue or grey with white patches type of marble. The ill-defined term *Lartios Lithos* is used for all these varieties. There is evidence that this type of marble has been found also outside Rhodes; in the north Aegean island of Samothrace and on the island of Karpathos. Our earlier study of the Nike of Samothrace statue showed that the prow on which it stands is made of this kind of marble. This, in combination with its extensive use locally, led us to search for ancient quarries of this marble on Rhodes in order to characterize its various qualities by scientific techniques. A field campaign took place, with the significant help of the Ephorate of Antiquities of Dodecanese.

The search started near the village of Lardos (ancient *Lartos*), in the area of Lindos and it was extended to almost the whole island. Quarries with ancient tool marks and abandoned semi-finished works (capitals, bases, shaped blocks, etc.) were located, pointing to a Hellenistic and later quarrying activity in three areas: a) various locations near the village of Lardos, b) a hill called *Marmarounia*, next to the ancient acropolis of *Kymisala*, and c) near *Lyros* north of *Kymisala*. The varieties near Lardos are either: a) dark grey/blue with dense white angular inclusions and yellowish thin veins or b) dark or light grey with large irregular white patches. The marble at *Marmarounia* is light grey with dense fine white and black angular inclusions. At *Lyros* it seems that a red/grey breccia-like marble was mainly quarried,

although there is a small appearance of grey/blue marble similar to that of Lardos. The collected samples were examined and analysed with Optical Microscopy, EPR spectroscopy and Stable Isotope analysis in combination. The results made possible the discrimination between the various quarries. A database is created and *Lartios Lithos* has been defined.

As an application, a variety of 18 architectural elements, from early Christian to the Hospitaller period, originating from a variety of monuments on Rhodes, were sampled and analysed, and the provenance of the marble determined. The results indicate that they are mostly made of local *Lartios Lithos* from several locations. Marble from Proconnesos is also identified among them, while for a small number other quarries are being considered.

MARBLE REVETMENTS OF DIOCLETIAN'S PALACE IN SPLIT

Katja MARASOVIĆ,[1] Vinka MARINKOVIĆ[2]

[1]Faculty of Civil Engineering, Architecture and Geodesy, University of Split, Split, Croatia, (katja.marasovic@gradst.hr)
[2]Croatian Conservation Institute, Section for stone conservation, Split, Croatia, (vmarinkovic@h-r-z.hr)

Keywords: Diocletian's Palace, marble, opus sectile

During archaeological excavations inside Diocletian's Palace, a big number of marble revetment fragments were found mostly in the southern part of the Palace (Emperor's apartments), and in the bath complexes. A detailed analysis determined more than 20 different marble materials, from all over the Empire. Some 30% are white marbles, a somewhat lesser percentage are of porfido rosso 27%, and the remaining 43% account for 18 different types of colored marbles. The diversity of material and colors shows us the splendor of the Palace interiors. Only two bigger surfaces of original marble revetments were found *in situ*. One is the multicolored opus *sectile floor* of Diocletian's mausoleum, and the other is the white marble revetment of the eastern bath little fountain.

Among the marble revetment fragments, which are stored in the City Museum of Split, different shapes of *opus sectile* decoration can be recognized. The thickness of the marble fragments varies from 0,5 to 4 cm. We can distinguish triangles, squares, rhombs, trapezes and some circular shapes. Comparing them to similar samples of other Roman palaces and villas, we can hypothesize that some *opus sectile* patterns of Diocletian's Palace disappeared a long time ago.

SCHISTS AND PIGMENTS FROM ANCIENT SWAT (KHYBER PUKHTUNKHWA, PAKISTAN)

Francesco MARIOTTINI,[1] Gianluca VIGNAROLI,[2]
Maurizio MARIOTTINI[3]

[1]Buildings Performance Institute Europe, Brussels, Belgium (francesco.mariottini@gmail.com)
[2]Dipartimento di Scienze, Sezione di Geologia, Rome, Italy (gianluca.vignaroli@uniroma3.it)
[3]Istituto superiore per la conservazione ed il restauro, Rome, Italy
(maurizio.mariottini@beniculturali.it)

Keywords: Schist, ancient Swat, reliquary

Since the earliest agricultural communities settled in the greater Indus basin in the 7th millennium BC, rocks and minerals had an important role in the local processes of social evolution. Semiprecious stones were traded and manufactured in order to signal the superior status of elites, as Italian excavations and surveys demonstrated in various projects (IsMEO-IsIAO and National Museum of Oriental Art in Rome, hereafter MNAOR). In Swat (Khyber Pukhtunkhwa) archaeological research focused on a long cultural sequence ranging from the 3rd millennium BC to the early historic period, when the exploitation of schists and other metamorphic rocks became massive and universal.

Many publications reported petrographic information from geological surveys and archaeological research. This paper presents results from mineropetrographic analysis (XRD, SEM-EDS, optical microscopy) carried out on small sheet-like samples taken from sculptures coming from Swat currently on exhibit in MNAOR, with the aim to better understand their context and provenance. Preliminary results allow classification of the stones used in the sculptures as serpentinite, talc schist and chloritoschist, with different textural characters (massive or foliated) and peculiar primary (antigorite, talc, chlorite) or accessory (chloritoid, rutile, magnetite, ilmenite, calcite) mineralogical phases. Petro-textural characters have implications both for the conservation methods of the sculptures and for the provenance history of the base materials used in the past for building and sculpting. A set of brightly coloured particles made of different raw materials (pigments and gold leaf), assembled within a reliquary, were also analysed. These precious materials were probably placed in the reliquary aside a few cremated bones in the frame of a highly symbolic, ritual setting.

THE MARBLES IN THE CHAPEL OF THE BLESSED JOHN OF TROGIR IN THE CATHEDRAL OF SAINT LAWRENCE IN TROGIR

Daniela MATETIĆ POLJAK,[1] Đeni GOBIĆ-BRAVAR[2]

[1]Academy of Arts, University of Split, Split, Croatia (daniela.matetic-poljak@umas.hr)
[2]Archaeological Museum of Istria, Pula, Croatia (gobic-bravar@ami-pula.hr)

Keywords: marble, spolia, Baroque, Trogir, Croatia

The city of Trogir has preserved a relatively small number of marble antique *spolia* considering its important phase in Antiquity. However, different types of marbles, most of them *spolia*, have been incorporated in some later monuments. Baroque interventions in the early Renaissance chapel of the blessed John Orsini in the Cathedral of Trogir, represent an important example of marble reutilization, combined with imported marbles ordered for that occasion.

The "baroquisation" of the chapel occurred in the 17th century, when it received the relics of the blessed John Orsini. On that occasion, the baroque altar (on the top of which is the Trecento chasse with the relics of the Blessed) assumed a central position in the chapel. The floor of the chapel was rearranged according to contemporary taste, and a marble fence was added at the entrance. The adored baroque polychromy was created by using different types of marbles.

Historian Ivan Lučić (Iohannes Lucius) from Trogir was in charge of the acquisition of the marbles. In his book *Memorie istoriche di Tragurio ora detto Trau,* he presents important data about the acquisition, which illustrate the importance of the marbles in Trogir in that period. Certain marbles were taken from different monuments and churches in the city (column shafts from the church of St. Martin, one shaft from the statue of our Savior on the Cimatorij, marble plates from the Church of St. John the Baptist and the Church of the Holy Spirit, from the Cathedral etc.), while some were brought from the region (column shafts from the Church of St. Stephen "sub pinis" in Split, marbles from Salona etc.), and some were donated by eminent citizens.

The identification of marbles of the baroque phase of the chapel represents the main purpose of this research. The authors will try, to the possible extent, to recognize the marbles from which the elements mentioned by Lučić were made.

THE EXTRACTION AND USE OF LIMESTONE IN ISTRIA IN ANTIQUITY

Robert MATIJAŠIĆ, Klara BURŠIĆ-MATIJAŠIĆ

Department of History, Juraj Dobrila University of Pula, Pula, Croatia
(rmatija@unipu.hr; kbursic@unipu.hr)

Keywords: Istria, limestone, quarry

Due to the karst substrate of the Istrian peninsula, limestone was the main natural building material until the emergence of modern technologies. Wood was always in short supply, clay is almost nonexistent, and the quarrying of limestone was an important activity in Prehistory, Antiquity and the Middle Ages.

The Iron Age population, the Histri, who gave the name to the peninsula, as well as their Bronze Age unnamed predecessors, used stone blocks for building drywall ramparts of the fortifications on hilltops. Small rough stones were then used to fill the space between two stoneblock faces. They often used to level the top of the hills for huts, thus obtaining the blocks for building the fortifications. There are no other discernible traces of quarrying in Prehistory.

The Roman conquest in the 2nd century B.C. and particularly the establishment of the colonies in the mid-1st century B.C. prompted the introduction of new technologies of quarrying. The Istrian limestone quickly established itself as an important building material, which was transported by sea to even more important centres along the north Adriatic coast. Istrian limestone was used for monuments and buildings in Aquileia, Altinum and Ravenna, to name only the most important. Of course, stone blocks were used, finely worked, for buildings in Pola, where the Temple of Augustus, the Arch of the Sergii and the Amphitheatre are well preserved today.

The stone blocks came from quarries along the coast, so that they could be transported by sea. The most important one is a few kilometres from Pola, near the village of Vinkuran. Its name, Cave Romane, although not of ancient origin, testifies to the tradition that it was opened in Roman times. The amphitheatre in Pola has allegedly been built with stone blocks from

this site, but the same quarry was also used in the Middle Ages and in the Early Modern Period, until recently.
Remains of other possibly Roman quarries exist along the western coast of Istria, while those around Vrsar were also used after Antiquity and the traces of Roman quarrying have been obliterated. Historical sources confirm that Istrian limestone was used to build Venice and the cathedral in Loreto (Marche).

SOCIAL POSITION OF THE CRAFTSMEN INSIDE THE STONE AND MARBLE PROCESSING TRADES IN THE LIGHT OF DIOCLETIAN'S EDICT ON PRICES

Branko MATULIĆ,[1] Krešimir BOSNIĆ[2]

[1]University of Split, Split, Croatia (branko.matulic@unist.hr)
[2]Academy of Arts, University of Split, Split, Croatia (kbosnic1@gmail.com)

Keywords: mosaic, Salonitan workshop, Diocletian's Palace

Diocletian's edict on prices which started taking effect in 301 AD is a lawful decree made with the goal of controlling the problematic inflation in that time of the tetrarchy. Other than prescribing maximum prices for certain goods, it also prescribes salaries for certain services. This particular piece of information, that is, comparison of several presented pieces of information, is necessary for an understanding of the social position of people included in the industry of exploitation and processing of stone, particularly if we know that in that time, the use of marble and mosaic covers (as final products in stone processing) in interiors and exteriors, was a very costly way of decoration.

Furthermore, an understanding of art pieces as decorative elements cannot be full if observed only through a technical or art-historical perspective, characteristic for a certain period and general cultural movements, but in order to be able to understand the general context and importance of an art piece it is necessary to include cognitions of people who created them. Here, based on the sources displayed and the order of emphasized questions, the prescribed salaries of physical workers, stonemasons, floor-layers and mosaic-makers are compared, and references on earlier Roman sources are made, which give us a clear image of the workers' income or prices of raw materials, with an emphasis on stone and stone products within the frame of the Salonitan mosaic workshop which decorated the exteriors and interiors of Diocletian's Palace.

THE USE OF LIMESTONE AND MARBLE AS MOSAIC MATERIAL OF DIOCLETIAN'S PALACE

Branko MATULIĆ,[1] Krešimir BOSNIĆ,[2] Domagoj MUDRONJA[3]

[1]University of Split, Split, Croatia (branko.matulic@unist.hr)
[2]Academy of Arts, University of Split, Split, Croatia (kbosnic1@gmail.com)
[3]Croatian Conservation Institute, Zagreb, Croatia (domagoj.mudronja@h-r-z.hr)

Keywords: mosaic, Salonitan workshop, Diocletian's Palace, material analysis, limestone tesserae

The production of the mosaic core of Diocletian's Palace in Split is attributed to the Salonitan mosaic school-workshop, which has been present in the Roman Province of Dalmatia since the end of the second to the beginning of the seventh century. The former comparative analysis of individual samples of mosaic components and certain decorative motifs, which was executed according to the catalogical model (a globally accepted scientific method), has proven that thesis.

Progress in that research with the goal of continued examination of influence models of the same mosaic workshop, requires a research of utilized materials, in which limestone, marble and dolomite dominate quantitatively.

This article displays the results of laboratory processing and comparison of several mosaics' structural matter in Diocletian's Palace, which as a broader agenda has the formation of catalogues of used materials and mapping of their distribution inside the Salonitan school-workshop's area of influence. Such an overview would enable us to determine more precisely the affiliation of a specific mosaic to a school-workshop. Although the remains of the mosaic from the most representative parts of the Palace (such as the imperial bath houses or the Vestibule) are fragmented, that is, in some cases reduced to the smallest workable pieces, it would be interesting to examine if a found material belongs to a preferred influential habitus of a Salonitan workshop, which would increment its high reputation that stands above provincial influence.

CHRISTIAN SCULPTURES FROM A PHRYGIAN QUARRY?

Donald A. McCOLL

Department of Art and Art History, Washington College, Chestertown, Maryland, United States (dmccoll2@washcoll.edu)

Keywords: Docimium, Sculpture, Christian

Specialists suspected early on that the figures in the Cleveland Museum of Art representing Jonah and the Good Shepherd were carved from Docimian marble. But this was confirmed only in 1988, when geologist Norman Herz of the Center for Archaeological Sciences at the University of Georgia analyzed samples of the works concerned, taken by conservators at the Cleveland Museum of Art, in concert with curators there and archaeologist Susan Kane of the Department of Art at Oberlin College. (As the primary advisor of my MA thesis, Dr. Kane had initiated the project.) This new archaeometric evidence could hardly have come at a better time. Archeologist Marc Waelkens was pressing the case for the production of sculpture at Docimium, above and beyond the level even of Asiatic columnar sarcophagi. Archaeologists, geochemists, classicists and historians were creating a working model not only for operations at Docimium, but for the Roman Imperial quarry system as a whole. And scholars from art historians to linguists were beginning to look at the Roman province of Phrygia from comparative, even theoretical, perspectives. At once drawing on this material and presenting new, definitive evidence for the provenance of the Cleveland Marbles, I not only argue for the limited production of pre-Constantinian Christian sculpture at or near Docimium, but discuss why the heroic tradition of which such works formed a part all but died with the coming of Constantine.

ARCHAEOMETRIC STUDIES OF ROMAN MARBLES FOUND IN THE NYMPHAEUM OF AECLANUM (MIRABELLA DI ECLANO, AVELLINO, ITALY)

Antonio MESISCA,[1] Lorenzo LAZZARINI,[2] Monica SALVADORI,[3] Stefano CANCELLIERE[2]

[1]Dipartimento di Scienze dell'Antichità, Università La Sapienza, Rome, Italy (mesisca.antonio@virgilio.it)
[2]Laboratorio di Analisi dei Materiali Antichi – Sistema dei Laboratori – Università IUAV di Venezia, Venice, Italy (lorenzo@iuav.it; stefano@iuav.it)
[3]Dipartimento dei Beni Culturali, Università di Padova, Padua, Italy (monica.salvadori@unipd.it)

Keywords: Aeclanum, Roman marbles, archaeometry

The ancient town of *Aeclanum*, near the present village of Mirabella Eclano in the Province of Avellino (Campania, Italy), was founded in the 3rd c. B.C. on the road connecting the region of Campania to Apulia (modern Puglia), which later became the famous *Via Appia*. The town flourished in the 1st and especially in the 2nd c. A.D. when a colony was established there and assumed the name of *Colonia Aelia Augusta Aeclanensium*. It was then that it became the most important centre in Hirpinia and one of the richest in the *II Regio Augustea Apulia et Calabria*, visited by emperor *Marcus Aurelius* in 167. The excavations have so far unearthed a *macellum*, a thermal complex, a large *insula* with an extensive craftsmen's quarter, a *nymphaeum*, quite a large necropolis and a paleo-Christian basilica. The *nymphaeum*, fully investigated in 2006-2009, has proved to be a monumental fountain lavishly decorated with architectural elements and white marble statues. Thirteen marble samples taken from the surviving statuary and selected architectural elements dating from the Augustan to the Antonine periods were subjected to minero-petrographic examination (OM of thin sections, XRD on powders) and isotopic analysis (SIRA on powders). The results obtained were compared with the latest updated international databases and with LAMA internal data. They indicate that *marmor lunense* from the Apuan Alps (in the Province of Carrara) was the only marble used for architectural elements, while *marmor pentelicum* from Mount Penteli (near Athens, Greece) and *marmor parium, lychnites* variety (from Stephani, on

the island of Paros, Greece) were preferred for three fragmentary statues. *Marmor pentelicum* was used for two of these, one of which is particularly important since it is an acephalous loricated portrait of an undetermined emperor (very likely Marcus Aurelius); *marmor parium* was used for the other, which depicts a female figure of the Julio-Claudian period.

ASPECTS OF CHARACTERISATIONS OF STONE MONUMENTS FROM SOUTHERN PANNONIA

Branka MIGOTTI

Croatian Academy of Sciences and Arts, Division of Archaeology, Zagreb, Croatia
(branka.migotti@gmail.com)

Keywords: stone characterisations, Pannonia

Characterisations of stone material have been made for the majority of north-Croatian Roman marble monuments, as well as for those made of other stones kept in the Museum of Slavonia in Osijek. Such characterisations have not yet been conducted on Roman stones from other museums, that is, from other parts of northern Croatia (southern Pannonia). In advance of such (anticipated) research, in this paper several cases will be presented, which in a special way illustrate the need for stone characterisations and the search for the quarry origin of the stones in question. The purpose of the discussion is to show that stone characterisations and tracing of the quarry origin do not only contribute to the research of the trading aspect in the production and distribution of stone monuments. It can also be of use in formal and iconographical contextualisation of the stones within their regional and supra-regional production, and in some cases it can even contribute to a better insight into geopolitical issues, that is, the establishment of town territories and provincial borders. While the main issue of marble characterisations in areas lacking their own marble sources, such as Pannonia, is whether the monuments were imported as finished or semi-products, with others stones a seemingly logical conclusion appears that, namely, the rocks from the nearest distance would be used. However, the so-far conducted characterisation of north-Croatian Roman stones has demonstrated that the logic of trading follows its own specific rules, and that the "rule of the smallest distance" cannot be safely taken as the only starting point in such research. The above hypotheses will be illustrated in this paper through five stone monuments as cases in point: two steles and two ash-chests from Sisak (Roman Siscia, SW Pannonia), and one stele from Aljmaš (ager of Roman Mursa, SE Pannonia).

POLYCHROME ANCIENT STONE SCULPTURE – RED PIGMENT AS THE MOST COMMON WITNESS OF THE ORIGINAL APPEARANCE

Miona MILIŠA

Conservation – Restoration Department, Academy of Arts, University of Split, Split, Croatia
(mionamilisa@yahoo.co.uk)

Keywords: Roman stone sculpture, polychromy on stone, pigments

Despite the long-known fact that Greek and Roman stone sculpture was painted, in analyses and interpretations of sculptures this fact is usually not given enough attention. While observing and then describing a stone sculpture or relief or just a simple motif, we must always bear in mind the aspect of the original polychromy. Almost all ancient sculpture was coloured, but traces of original colour have been preserved on rare artefacts only. We must not forget that the finishing layer of polychromy on stone sculpture sometimes surely suggested motif differentiation, or symbolic meanings. What present-day research can give is a range of chemical pigment analyses interpreted in interdisciplinary collaboration of different activities. Giving importance to remains of original polychromy (not just the visible ones, but also some secondary details) on ancient stone, the main motif can be discerned with certainty from the secondary one and thus provide us with a step forward in the understanding of motifs, their mutual relations and meanings. On Roman sculpture from the area of the eastern Adriatic coast red pigment is usually best preserved. Three marble sculptures (from the archaeological museums in Split, Zagreb and Vid) with visible remains of the original red pigment were selected for this research. Going through each phase of creating an individual piece, always keeping in mind the context to which the sculpture belonged, can take us much closer to the time of the artwork creation. The chemical analysis of the dye composition can give us an additional perspective on the presumed original appearance of the sculpture. By comparing spectres of samples of polychromy on stone we can see if the pigments are of an identical chemical composition (identical spectres). The result is one of the arguments for a more precise dating of these samples.

The story of the original final layer of stone sculptures - polychromy, certainly answers some of the questions about trade, masters stone-cutters, builders, blacksmiths, painters, other craftsmen and artists of those times. Let this research be a step in the effort of coming closer to the solution of the problem, since the answers and solutions to many confusions lie in the correct interpretations of colour on the sculpture. In conservation-restoration of archaeological heritage, consolidation of traces of pigments on Roman sculpture should be of primary importance in order not to irreversibly lose the little evidence which still survives today.

THE BYZANTINE ROUND FORUM OF DYRRACHIUM

Lida MIRAJ

Department of Architecture, Albanian University and Albanian Association of Byzantine Studies, Tirana, Albania (miraj.lida@gmail.com)

Keywords: Dyrrachium, Justinian Emperor, Round Forum, Proconessian Marble

One of the interesting monuments of the Early Byzantine period is the Byzantine Round Forum, constructed perhaps under the reign of Anastasius (491-518 AD), discovered occasionally in the mid 80s. The Forum is very close to the Public Roman Bath of the city, although they are dated to different periods and of course constructed at different levels.

The Byzantine Round Forum has a diameter of 40 m and is surrounded with columns decorated with Composite capitals. Around the colonnade is a passage and traces of the foundations of other structures, perhaps shops, which are a part of this Forum and enlarged the Byzantine Round Forum to a diameter of 72 m.

The Forum is paved with rectangular and trapezoidal shape marble slabs. The surface of some slabs contains scratches of the Greek letters Φ and the combination of ω.

In the center of the Byzantine Round Forum, is a round 'podium' constructed with *opus caementicium* with strong limestone mortar. The podium, perhaps a basement for a column, or a statue has a diameter of 4.50 m and is 0.80 high. There are three stairs around it and some parts of a plaster with fresco painted pilaster. Two meters away from the podium, on the eastern part of it, is a cistern. Its throat has a diameter of 1.20 m constructed with *opus mixtum*.

The base of the porticoes around the Forum, carried out in *opus mixtum*, was presented in a better condition. It is 0.85 m thick and 0.30 m high. On the top are fixed stone blocks of rectangular shape. Five of them had column bases, some of which had acronyms ΠΑΤ, ΕΥ etc.

The marble used in the Byzantine Forum of Dyrrachium is imported from Proconnessos. The import of Proconnessos marble from Marmara quarries, in Dyrrachium, had started since the 2nd century AD and reached its peak particularly in the 6th century AD. It is clear that it is the central

square of the city; probably with different stores and workshops around; a round 'stoa', if we may use the Greek term for this type of constructions. There is not enough data to determine the date of construction, but it is undoubtedly from the Anastasius-Justinian period. This was one of the luxury periods of the city and it is documented archaeologically with many constructions.

MARBLE AND SCULPTURE AT LEPCIS MAGNA (TRIPOLITANIA, LIBYA): A PRELIMINARY STUDY CONCERNING ORIGINS AND WORKSHOPS

Luisa MUSSO,[1] Laura BUCCINO,[2] Matthias BRUNO,[3]
Donato ATTANASIO,[4] Walter PROCHASKA[5]

[1]Dipartimento di Studi Umanistici, Università Roma Tre, Rome, Italy
(luisa.musso@uniroma3.it)
[2]Via B. Pallai 9, Rome, Italy (buccino.laura@gmail.com)
[3]Via dei Vascellari 34, Rome, Italy (matthiasbruno@libero.it)
[4]Istituto di Struttura della Materia, Consiglio Nazionale delle Ricerche (ISM-CNR),
Rome, Italy (donato.attanasio@ism.cnr.it)
[5]Department of Applied Geological Sciences and Geophysics, University of Leoben,
Leoben, Austria (walter.prochaska@unileoben.ac.at)

Keywords: Leptis Magna, Sculptures, marble provenance, archaeometry

Lepcis Magna possesses one of the richest and most important collections of Roman sculpture of ancient Tripolitania (Libya). Many of the finds were unearthed during the 19th century excavations in the Hadrianic Baths, the Theatre, the Serapeum and in the Severan Complex. The statues, now on display in the Archaeological Museum of Tripoli, in the local Museum of Lepcis Magna and its depots, date from the 1st to the 3rd century AD. This paper contains the results of a marble provenance investigation conducted on a selection of 36 white marble statues now in the depots of the old Archaeological Museum of Lepcis Magna, to which two others from Serapeum have been added. Since it is well known that Tripolitania had no marble quarry of its own, it is reasonable to ask where the local workshops were getting their marble from, and what the role of the imported finished products was in the general framework of sculpture production? New data concerning the origins of sculpted marble taken from a heterogeneous sample (archaeological provenance, typology, usages and date) allow us to take into better consideration several questions, which, thus far have not been adequately dealt with. For example, the presence of foreign craftsmen in the local context, the importation of finished works, the ability to identify local production with a distinct style, but where different external influences are also visible, and finally the organization of the Tripolitanian workshops themselves. Not only do all these elements help us to shed light

on the different expressions of the local sculpture production, they also allow us to evaluate its diffusion and follow its changes from the 1st to the 3rd century AD. Of particular relevance is the arrival of Luna marble in the province during the 1st century AD. When taking into consideration relations between Lepcis Magna and Rome, Luna marble was an important element, not only in the cultural and political sphere, but also with regard to commerce.

By combining the scientific analysis of the marble with that obtained from archaeology and epigraphy, we are able to gain a more complete picture of the "marble phenomenon" not just as a purely decorative element, but also its role in the cultural, social and economic dynamics of the city.

A METHODOLOGICAL POINT ON THE TECHNIQUES OF COPY IN GRECO-ROMAN SCULPTURE

Séverine MOUREAUD

Centre Camille Jullian, Aix-en-Provence, France (sevemoureaud@hotmail.com)

Keywords: Copy, Marble, Sculpture

This paper deals with the different techniques of copy or reproduction used or probably used in Greco-Roman marble sculpture. It appears that these techniques had changed during times. It must be interesting to make an inventory of all possibilities, by a historiographical point, by the analysis of traces on unfinished and on finished statues, placing these techniques in historical and geographical contexts. It will also be necessary to propose new hypothesis with the help of new methodological approaches.

The paper will be addressed chronologically. What can we say about the reproduction of models or marble statues during the Archaic, Classical, Hellenistic and Roman periods? We will talk about the use of module (drawing or mathematics ones) during the Archaic period and the different clues of the use of reproduction during that time. After, we will discuss the different hypotheses which were proposed for the Classical period and the clues on archaeological pieces. For the Hellenistic period, we will also present an experimental research of technique of copy which I observed at Delos during the 2nd century BC. That experimental research at Delos shows a necessity to adapt the statuary production to a new context of consumption of statues ("mass production" and reproduction of master). At the end we will talk about the Roman techniques, the clues and the hypothesis proposed. Considering the tools will be interesting, but I concentrate on the archaeological objects and their traces. For that, I really want to focus on a methodological analysis of the material like Prehistorians do. It would also be interesting to try to propose some new ways to progress on these questions: methodological and comparative analysis, ethnoarchaeology, interdisciplinary collaborations.

MARBLE WALL DECORATIONS FROM THE IMPERIAL MAUSOLEUM (4th C.) AND THE BASILICA OF SAN LORENZO (5th C.) IN MILAN: AN UPDATE ON COLORED MARBLES IN LATE ANTIQUE MILAN

Elisabetta NERI,[1] Roberto BUGINI,[2] Silvia GAZZOLI[3]

[1]Université Paris-Sorbonne, Paris, France/Università Cattolica del Sacro Cuore, Milan, Italy (Elisabetta.neri@unicatt.it)
[2]Consiglio Nazionale delle Ricerche - Istituto Conservazione e Valorizzazione Beni Culturali (CNR-ICVBC), Milan, Italy (bugini@icvbc.cnr.it)
[3]Scuola di Specializzazione in archeologia, Università Cattolica del Sacro Cuore, Milan, Italy (silviag.gazzoli@gmail.com)

Keywords: Opus sectile, Late Antique, colored marbles, Milan, wall decoration

This paper presents the unpublished remains of the marble *crustae* that covered the walls of two buildings of imperial commission in Milan during Late Antiquity: the Imperial Mausoleum and the Basilica of San Lorenzo. First, the study of a conspicuous set of *crustae*, uncovered by means of non-stratigraphic excavations carried out in both contexts in the early years of the 20th c., allowed reconstructing the appearance of these decorations. The walls of the Imperial mausoleum were animated by a figurative decoration articulated by architectonic partitions, as reported by Bonaventura Castiglioni (1553) before the destruction of the building. On the other hand, heterogeneous marble plaques arranged in large fields, together with bas-relief elements, decorated the walls of the tetraconch of the Basilica and its annexes. In particular, geometric elements with architectonical partitions alternating with *rotae* covered the chapel of Sant'Aquilino, as testified by late medieval literature.

Subsequently, the lithological examination of the remains and the observation of the carving marks on the slabs allowed the description of the lithologies used in the two buildings, to verify the cutting techniques, to advance some considerations on the reuse of materials and on the status and power of the customer. In particular, the majority of the lithologies collectively known as "marmi colorati" were identified: these are lithologies largely used in the imperial Roman territory, such as *Africano, Cipollino, Fior di Pesco, Giallo antico, Pavonazzetto, Porfido rosso antico, Porfido serpentino verde* and *Rosso antico.*

Finally, the comparison between the two buildings allows formulating hypotheses on the supply, the reuse and the use of this type of decorations for two buildings that were designed less than one century apart, but in two definitely different political contexts.
This study significantly updates the overall picture presented by previous research on *opus sectile* wall decorations in Milan and its area.

RESTORATION OF THE PERISTYLE OF DIOCLETIAN'S PALACE IN SPLIT

Goran NIKŠIĆ

City of Split, Service for the Old City Core, Split, Croatia (goran.niksic@split.hr)

Keywords: Peristyle, conservation history, petrographic analysis, structural repair, laser cleaning, stone restoration

In the light of new interpretations of the original function of Diocletian's Palace, a fresh perspective is offered on the architecture of its central square – the Peristyle. As a consequence of changes in design introduced during the construction, the architecture of the Peristyle has assumed an ambiguous character, between the solid, massive structure of the Vestibule on the south side and the light, free-standing colonnades, separating it from the sacred enclosure of the Mausoleum to the east and that of the temple area to the west.

Various types of granite and marble used for the construction and decoration of Diocletian's Palace and of the Peristyle were imported from distant regions of the Empire, mostly from Egypt and Asia Minor. Apart from that, local limestone of the highest quality, quarried mostly on the neighbouring island of Brač, was used for building the monumental parts of the Palace.

The already complex architecture of the Roman Peristyle became even more intricate with the addition of many buildings of different periods. It can be said that the imperfect architecture of the Peristyle was enhanced by later accretions which are an added value to the remarkably well preserved original structure which took on a new meaning of the cathedral square and of the centre of the city.

At the beginning of the third millennium, a ten-year restoration campaign was organized by the City and executed by the Croatian Conservation Institute. Started in 2004 as a stone cleaning operation, it developed into a complex project including archaeological, geophysical and geo-mechanical research, consolidation of foundations and upper structures, cleaning and conservation of stone, plaster and other materials, lighting and presentation of this multi-layered monument. Because of the great importance of

the monument, the complexity of the conservation problems and the involvement of a number of foreign and Croatian experts and institutions, the restoration of the Peristyle constituted one of the most important conservation and restoration operations carried out in Croatia.

HOW IN SITU LASER ABLATION ICP-MS ANALYSIS CAN HELP IN THE PROVENANCE ANALYSIS OF ISOTOPICALLY VERY SIMILAR MARBLES

Peter ONUK, Walter PROCHASKA

Department of Applied Geological Sciences and Geophysics, University of Leoben, Leoben, Austria (peter.onuk@unileoben.ac.at; Walter.prochaska@unileoben.ac.at)

Keywords: Laser Ablation ICP-MS, In situ analysis, provenance

The discrimination of a series of important ancient marbles (Prokonnesos, Paros II and Heraklea) by stable isotope analysis is problematic and there is an appreciable overlap of the corresponding compositional field. Consequently, further analytical parameters have to be used in order to achieve a sound discrimination of these marbles. The analysis or trace elements faced several problems in the past for the irregular distribution and scattering because of the heterogeneity of accessory minerals in the marbles. Consequently the use of trace element analysis was generally limited to elements bound to the carbonate lattice (e.g. Fe, Mn, Sr) thus showing a more homogenous distribution.

Therefore, we applied in situ trace element analyses using laser ablation ICP-MS. This method generally allows single spot analysis of the trace elements bound to the lattice of the carbonate crystal. A big advantage in comparison with bulk chemical methods is, that in this case there is no influence of trace minerals often included in the marbles. Furthermore, all that is necessary is a very small sample (minimum are a few crystals) and an even surface of a few mm^2.

The first encouraging results reveal a series of trace elements, which very well discriminate between the investigated marbles. Among the different trace elements analysed, the analysis of ^{89}Y, ^{137}Ba, ^{139}La, ^{140}Ce and ^{208}Pb seem to be the most useful parameters. Together with the conventional analytical variables and the evaluation by multivariate statistical analysis, a very good discrimination between the marbles of Prokonnesos, ParosII and Heraklea can be achieved.

NEW SCIENTIFIC INVESTIGATION OF THE PROVENANCE OF THE MARBLE OF THE SOUNION KOUROI AND A FRESH ATTEMPT OF ASSIGNMENT OF STATUES TO BASES

Olga PALAGIA,[1] Yannis MANIATIS,[2] Dimitris TAMBAKOPOULOS[2]

[1]Department of Archaeology and Art History, National and Kapodistrian University of Athens, Athens, Greece (palagia@enternet.gr)
[2]Laboratory of Archaeometry, Institute of Nanoscience and Nanotechnology, NSCR "Demokritos", Athens, Greece
(y.maniatis@inn.demokritos.gr; d.tambakopoulos@inn.demokritos.gr)

Keywords: Parian, Naxian, Kouroi, Bases

Among the earliest marble kouroi excavated in Attica, the two kouroi from Sounion in the Athens National Museum have long been thought to be of Naxian marble and therefore created by Naxian sculptors. Recent finds of Parian kouroi, however, suggest a possible affiliation with Paros. The provenance of the sculptors of these kouroi is of crucial importance in order to determine the origins of Attic sculpture. In the paper presented at ASMOSIA X, the authors attempted to investigate the provenance of the marble of the Sounion Kouroi and the three bases that were found with them by means of examination of their marble properties and the maximum grain size because we had not been granted permission for full marble analysis. We suggested that, although Parian marble was indeed possible, marble testing was necessary in order to determine decisively the source of the marble. In the course of the same study, we also came to the tentative conclusion that the assignment of Kouros Athens National Museum 2720 to the base Athens National Museum 2720a and of Kouros Athens National Museum 3645 to the base Athens National Museum 3645a may be incorrect and should be reconsidered. Fortunately, we were recently granted permission to take marble samples from the Kouroi and their bases. The samples were received in the form of small cylinders with a suitable diamond corer from pre-selected places of the statues and bases, where there were recent or older breaks. At the laboratory, the cylinders were treated with acid to remove the external surfaces in contact with the drill bit and freshly broken surfaces were then examined under the optical microscope. Three

techniques were applied: EPR spectroscopy, Stable isotope analysis and Maximum Grain Size measurements. The results of these tests will help us understand the origins of one of the earliest marble workshops of Attica.

THE REMAINS OF INFRASTRUCTURAL OBJECTS OF THE ANCIENT QUARRIES ON ZADAR ISLANDS (CROATIA)

Mate PARICA

Department of Archaeology, University of Zadar, Zadar, Croatia (mateparica@gmail.com)

Keywords: infrastructural objects, ancient quarry, Zadar islands

This paper provides an overview of newly found infrastructural objects of the ancient quarries on Zadar islands. Archaeological remains are located near the ancient quarries: remains of the communications from the quarry to the coast in the form of exit corridors carved in the rock, paved roads for stone transport to harbor, and visible harbor installations for loading the stone cargo on the boats. The sites are located on the island of Molat, Sestrunj and Dugi otok.

Remains of other buildings used in the ancient quarry complex are also visible: the blacksmiths workshop and remains of water tanks. Some infrastructural objects contain archaeological findings which can date the nearby quarries. There are also interesting examples of well-preserved ancient infrastructure near the quarries, which demonstrate usage of the late medieval quarries. That indicates a continuous exploitation of ancient quarries. It is important to emphasize that, owing to their good geographical position, these sites are well preserved today, and to point out that this type of sites is rarely preserved in the Mediterranean. It should also be noted that these zones, which consist of the quarries, preserved communication to the sea, port facilities, and the surrounding complex, are unique archaeological sites, therefore it is important to preserve them from devastation.

ISLAND OF KORČULA – IMPORTER AND EXPORTER OF STONE IN ANTIQUITY

Mate PARICA, Igor BORZIĆ

Department of Archaeology, University of Zadar, Zadar, Croatia
(mateparica@gmail.com; igorborzic@gmail.com)

Keywords: Korčula, Antiquity, marble, quarry

Suitable natural and geographical characteristics of the island of Korčula (Croatia) were a prerequisite for a population density and practical space utilization throughout Antiquity. That is evidenced by slightly more than forty settlements (*villa rustica*) and supporting sites dated mostly from the 1st to the 6th century AD. Their positioning refers primarily to the agricultural base of their economy whose intensity, as well as the material status of the owner, are directly illustrated by the accompanying archaeological finds. These are also different types of stone, taken from local, regional or much further sources, used for making structural-decorative elements of architecture or different types of monuments (inscriptions, statues, steles, sarcophagi, etc.). Particular attention will be drawn to the finds of the marble wall panelling (Potirna-Mirje, Bradat-Mirje, Kneža), mosaic flooring, Composite capitals (Beneficij-Gudulija) and different types of steles and sarcophagi that set the island of Korčula on the map of the distribution of luxurious stone material and products of leading masonry workshops.
On the other hand, besides being a consumer of imported, Korčula appears as an emissary of the local high-quality limestone exploited especially in its eastern part and accompanied archipelago. Unfortunately, a great, nearly industrial type of exploitation can be traced from the late Middle Ages onwards, while stonemasonry in Antiquity is testified only by specific archaeological contexts (submerged operative coast on Sutvara) and gallery type of quarry (Sutvara, Kamenjak and Vrnik), which will be presented in detail. Also, placing the Issaean Hellenistic settlement in Lumbarda and numerous Roman villas on this part of the island is a respectable argument in recognizing the ancient quality and perspective of dealing with stone processing whose nature and intensity are still difficult to determine.

"ONE CARNELIAN AGAINST ALL EVIL AND ENVY": A GRAMMAR OF MAGIC STONES

Holt N. PARKER

Deptartment of Classics, University of Cincinnati, Cincinnati, Ohio, United States
(holt.parker@uc.edu)

Keywords: gemstones, magic, symbolism

Stones were one of the principal vehicles of magic powers, but they remain understudied in comparison to botanicals. This paper surveys the uses of magical stones in Greco-Roman antiquity and attempts an outline of a grammar (or grimoire) of the underlying magical symbolism. Scholarly interest has naturally focused on the texts and images engraved on gemstones, but the medium can be the message.

The sources are wonderfully varied: the amulets in the (still imperfectly edited) *Cyranides*, the *Sacred Book of the Decans* of "Hermes Trismegistos," the Latin translations of a lost Greek original attributed to "Damigeron" and "Avax King of Arabia," the "Orphic" *Lithica* in verse, its prose translation (Kêrugmata), "On Stones" attributed to Socrates and Dionysius, the Greek magical papyri, Pliny the Elder, Philostratus' *Life of Apollonius*, even the *Alexander Romance*. We can also use Dioscorides on the medical uses of stones as a counterweight. These texts and the remains of material culture—the corpora of the thousands of ancient engraved gemstones—demonstrate how archaeology and philology can illuminate each other.

These sources, the Near Eastern (especially Assyrian) antecedents, and the magic rites intended to awake the stones' powers can give us insight into the complex associations of names (serpentine, adamant, amethyst, hematite), color (sky-blue, white, green for digestion), astrological signs and planets (Venus, Mars), and physical properties (lodestone, crystal). They reveal a rich (and interestingly gendered) world of sympathetic magic running through magical formularies, medical texts, and high poetry.

THE USE OF CIPOLLINO VERDE FROM EPHESOS TO OBTAIN INFORMATION ON STRUCTURAL GEOLOGY AND ROMAN SAWING TECHNIQUES

Cees W. PASSCHIER,[1] Sebastian WEX,[2] Sinan İLHAN[3]

[1]Department of Earth Sciences, University of Mainz, Mainz, Germany (Cees.Passchier@uni-mainz.de)
[2]Department of Earth Sciences, ETH, Zürich, Switzerland (sebastian.wex@erdw.ethz.ch)
[3]Avusturya Kazı Evi, Atatürk Mah., Selçuk, Turkey (sinanilhan2004@yahoo.com)

Keywords: Cipollino Verde, marble, stone saw, structural geology

The green marble known as "Cipollino Verde" was extensively quarried near Karystos on the island of Euboea in Roman times, and quarry products, especially columns, were distributed throughout the Roman Empire. The Cipollino Verde marble is interesting to geologists because it contains deformation structures in a pronounced layering such as folds, foliations, lineations and boudins, formed when the original carbonate sediments were buried at high pressure and temperature. These structures, especially folds, have an attractive geometry that was apparently also appreciated in ancient time.

A dining hall in Terrace House II in Ephesos was decorated with over fifty 148x90 cm plates of 1.5cm thick Cipollino Verde marble. Forty of these slabs were cut from a single 1.25 m^3 block of marble, probably in Ephesos itself. The fragmented slabs were recently restored and remounted on the walls of the dining hall. We used photographs of the restored slabs to reconstruct the 3D geometry of folds in the marble within the original block, the first time that this could be done for such a large volume of rock. In this way, valuable geological information was obtained on the 3D geometry of folds in layered marbles[1]. Besides geological information, we obtained data about the sawing technique by which these Cipollino Verde slabs were cut: we could determine that 38% of the material was lost by the sawing procedure, 5% of the slabs were broken and that the mean width of the saw cutoffs, including polishing, was 9.5 mm.

We suggest that similar combined studies in structural geology and archaeology can be realized on other object of Cipollino Verde marble at archaeological sites throughout the Roman Empire. In the case of Cipollino Verde the internal structure can also be used to determine the exact provenance and orientation of the cut blocks in the original quarries.

ANTIQUE MARBLES FROM THE ROMAN VILLA IN VERIGE BAY

Mira PAVLETIĆ

Department for the Protection of Cultural Heritage, Public institution Brijuni National Park, Fažana, Croatia (m.pavletic@brijuni.hr)

Keywords: Roman villa in Verige Bay, marble, floor and wall covering

During many years of research of the luxurious Roman villa in Verige Bay on Veli Brijuni, Austrian conservator Anton Gnirs found the fragments of floor and wall coverings and decorations made of marble. While his early report only indicates the colors (black, white or a combination of these two colors) or 'many marble slabs of different types and colors', the last report accurately determines the type of marbles: *giallo africano* and *pavonazetto*. The objective of this study is to identify remaining types of marbles and complement them by materials found in the bay at the end of the last century. By determining the types of marble which decorated different buildings in the bay, we will obtain a complemented picture of the brilliance of this luxury Roman villa as yet another confirmation of its luxurious equipment and find out which sites of the Mediterranean basin the small port in Verige Bay was connected with.

AMETHYSTUS: ANCIENT PROPERTIES AND ICONOGRAPHIC SELECTION

Luigi PEDRONI

Lithuanian University of Educational Sciences, Vilnius, Lithania (luipedro06@gmail.com)

Keywords: Amethyst, Pliny, iconographies

This paper, through the exam of the ancient literary sources, mainly the book XXXVII of Pliny's Natural History, deals with the various beliefs about the properties of the amethyst. This stone was quite popular in Roman jewelry and, being easy for engraving, was used for carvings. We will focus, therefore, on its name, derived from Greek with the meaning of "not drunk", and the connection with the wine, evident for the violet color of the stone. This particular color also explains the connection of a variety of amethyst, called *paederos* / *anteros* with Venus, through the link with the sea from which the goddess was born. Poets (i.e. Homer) sometimes described the sea color as wine-dark. Not surprisingly, one of the most common iconography in amethyst is that of the marine thiasos.

Furthermore, the connection between the amethyst and the hyacinth, stone color purple, from which the amethyst was difficult to distinguish in Antiquity, will be deepened.

Finally, in order to investigate the intention of the artist in selecting the stone and iconographies to carve, some amethysts bearing the artist's signature will be analyzed.

For some theme of Dionysian character, the explanation seems almost automatic; moreover, being a stone with a strong connection to Venus, it is not unexpected that a couple of signed amethysts present erotic subjects.

Some interpretative hypotheses in explaining the connection between the stone and iconography will be proposed for other signed gems bearing particular iconographies - Dioscurides' Demosthenes, the Artemis of Apollonius and the portrait of Claudius signed by Skylax.

SLEEPING HERMAPHRODITES AND MAENADS: PRODUCTION CENTRES AND QUARRY MARKS

Patrizio PENSABENE

Dipartimento di Scienze dell'Antichità, Università La Sapienza, Rome, Italy
(patrizio.pensabene@uniroma1.it)

Keywords: Hermaphrodite, quarry marks, production

Recent restoration work on the Hermaphrodite preserved in the Museo Nazionale Romano, which was discovered in a niche in the peristyle of a *domus* found below the Teatro dell'Opera in 1879, revealed initials carved on the lower flat surface that supported the sculpture. This would not have been previously visible as it was originally placed on a stand. The initials are similar to those found on quarry blocks and archaeometric analysis has shown that the piece was carved from Parian marble.

The sculpture, which is assumed to be from the time of Antoninus, is an accurate reproduction of a mid-second-century-BC statue attributed to an artist influenced by the traditions of Pergamon or Rhodes. It depicts the involuntary action of rolling over while sleeping of a Hermaphrodite shown in a particularly sensual and provocative posture. Pliny (NH, XXXIV, 80) tells us that the sculptor Polykles carved a Hermaphrodite. Some experts have identified this sculptor as an Athenian artist who lived in the second century BC and who may have been the author of the original.

Our aim with this paper is to present the results of a new examination of the various copies (at least six) of the dominant type, which is also found, with variations, in the Galleria Borghese in Rome, the Louvre, the Galleria degli Uffizi in Florence and the Hermitage in Saint Petersburg. We could also add the reproduction with female variations represented by the Maenad in the National Museum of Athens. The objective is to single out the place where the Hermaphrodite in the Museo Nazionale Romano was produced – probably an Attic workshop – based on a stylistic rereading of the piece, an examination of the marble and a comparison with the Maenad in the National Museum of Athens.

THE DISTRIBUTION OF TROAD COLUMNS AS EVIDENCE FOR RECONSTRUCTING THE PRODUCTION SYSTEM

Patrizio PENSABENE,[1] Javier Á. DOMINGO[2]

[1]Dipartimento di Scienze dell'Antichità, Università La Sapienza, Rome, Italy
(patrizio.pensabene@uniroma1.it)
[2]Dipartimento di Storia della Chiesa, Pontificia Università della Santa Croce, Rome, Italy
(javdomingo78@gmail.com)

Keywords: granite, production quarries

Shafts made of Troad granite are found in many towns and cities throughout the Mediterranean, frequently along with Proconnesian marble capitals and bases. This fact, together with the standard measurements of the majority of them – approximately 10, 12, 14, 16, 18, 20, 30 and 40 feet – demonstrates the exceptional productivity of the Troad quarries, the close links they must have had with various marble-producing districts and, as a consequence, the complex organisation that would have guaranteed the efficient management of the quarries and all the production processes.

In this presentation we wish to analyse the organisational aspect of the work in these quarries, the mechanisms for distributing the quarried granite blocks, and their transport. The scarcity of information that would help us better understand these processes – for example, there are no quarry marks on the shafts – forces us to draw conclusions based on information obtained from shafts exported from the Troad.

1) The frequent finds of shafts of this type of stone in provincial towns and cities means we can assume that there was a system of contracts for certain sectors of the quarries that supplied the private market. Moreover, the fact that it was cheaper than other types of granite, the *granito del Foro* for example, helped its widespread distribution.

2) The measurements of the preserved shafts determined the extraction and distribution mechanisms for the stone blocks. The largest of them, for example, would have had to have gone through the state distribution channels – it is difficult to imagine a private enterprise having access to the complex mechanical systems required to extract and manoeuvre these large blocks – regardless of whether the customer was a private individual or the

state itself. And the transport of these large blocks must have been carried out directly from the quarries, whereas smaller shafts may have travelled as return cargo on ships.
3) Knowledge of where the shafts originated allows the study of possible types of customer: the state – as in the Baths of Antoninus in Carthage or the Traianeum in Italica – or private clients, probably supplied by the sectors of the quarries ceded to private enterprise.

THE TRADE OF SMALL-SCALE STATUES IN THE ROMAN MEDITERRANEAN: A CASE STUDY FROM ALEXANDRIA

Patrizio PENSABENE, Eleonora GASPARINI

Dipartimento di Scienze dell'Antichità, Università La Sapienza, Rome, Italy
(patrizio.pensabene@uniroma1.it; elegasparini@hotmail.com)

Keywords: small-scale sculptures, trade, Alexandria

The purchase of small-scale sculptures in the Roman market is an issue which has received great attention between scholars in recent times, especially after the publication of the volume *The economics of the Roman stone trade* by Ben Russell. The discussion mainly focuses on two different models: in the first case one can hypothesize the existence of a standardized production by the workshops in the quarries which was independent from demands, while in the other, an on-demand production must be put forward. On a general scale, it must be stressed that the production and sale mechanisms were also connected to the role played by *mercatores marmorum* in distributing sculptural works.
On this occasion we shall bring a contribution to this topic looking at a group of recently published small sculptures found in the surroundings of Alexandria.

SHORT NOTES ON A REDDISH-GREEN STONE AT JEBEL ARKENU (SOUTHERN LIBYA)

Maria Emilia PEROSCHI

Centro Studi Archeologia Africana, Milan, Italy (mariaemilia@fastwebnet.it)

Keywords: unakite-like rock, Jebel Arkenu, Jebel Uweinat

The occurrence of a unakite-like rock is present at the foot of the northern side of Jebel Arkenu, in the Southern Libyan Desert. Jebel Arkenu is a massif made up of a ring complex on its southern side, intruded into the Paleozoic formations which overlie unconformably the Precambrian rocks of the *basement complex*. These latter outcrop along the northern flanks, partly covered by coarse debris. Among the rocks and boulders, a number of reddish-green pebbles were identified.

The stone has been used for making tools by Neolithic people who, during the Holocene climatic *optimum* pastured cattle and goats in the area between Jebel Arkenu and its major companion Jebel Uweinat, where the borders of Egypt, Libya and Sudan meet. During our reconnaissance journey, the exact location of the outcrop was not found; it must be a dike or a vein of very small size, thus probably covered by the debris.

In thin section the rock appears fractured and made up of orthoclase feldspar, epidote, and a very little amount of quartz.

Both Jebel Arkenu and Jebel Uweinat show a wealth of rock art with paintings of people, both male and female, wearing bracelets and necklaces around legs, arms and shoulders. Could they be the users of such pretty stone?

SAXA SACRA ET LAPIDES EXCAVATAS ATQUE INCISAS. STONE QUARRIES AREAS: FORMS OF SACREDNESS BETWEEN POLITICAL POWER AND RELIGIOUS EXPRESSIONS IN THE ROMAN MID-NORTHERN TYRRHENIAN SEA.

Eliana PICCARDI

PhD School, Dipartimento di Antichità, Filosofia, Storia (DAFIST), University of Genoa, Genoa, Italy (elianapiccardi@gmail.com)

Keywords: Quarries-working, Religiousness, Politics

This proposal deals with the issues bound to the evidence of religious expressions left by the quarry workers within some quarrying areas in the Mid and Northern Tyrrhenian Sea (above all at Luni, in the nowadays Eastern Liguria –I-, and in the island Corsica –F-): both, the more popular or spontaneous ones, and the ones eventually related also to the political control exercised, by this mean, upon the quarry workers, during a time-frame going about from the end of the Roman Republic up to the Severian Period.

These examples show different scale quarries, as patterns of a wider (Luni and the Apuane Alps chain) and smaller (Île-de-Cavallo at the southeast of Corsica, among the islands of the Bocche di Bonifacio sea strait) organizing work systems.

Focusing upon them it will be possible to illustrate one working-model, directed on the place, perhaps also seat of forms of popular devotions (e.g. to *Hercules Saxarius*, 1st-2nd cent. AD) in the island of Corsica, and another one, a huge and more intensively and diachronically exploited quarrying system near Luni, where we can find both, the genuine expressions of popular devotions - like the ones to the woods-god *Silvanus* honored by the quarry workers especially up to the 1st cent. AD, and – especially afterwards – where we can see witness of a tighter control exercised by the Imperial Power (especially the Severian family in the 3rd century AD) thanks to the mean of religion (the well-known stele called 'of the *Fantiscritti*' from the Apuan quarries).

Therefore, the possible 'religious' and 'sacred' expressions related to these quarrying-areas that one can analyse are not (or not only) sincere expres-

sions of popular – meant as spontaneous – devotion within a relatively smaller quarrying enterprise (like the one investigated in Corsica at Île de Cavallo, with a mid-ray export between Northern Tyrrhenian area and the Lion Gulf area), but they may also be used as a mean of controlling the workers, and therefore the whole working chain, by the Imperial politics, enlightening what may go beyond a historic corollary to all the other more technical aspects.

THE PARTHENON'S QUARRY QUANDARY – LOOKING INSIDE THE PENTELIC SOURCE

Scott H. PIKE,[1] Lena LAMBRINOU[2]

[1]Department of Environmental and Earth Sciences, Willamette University, Salem, Oregon, United States (spike@willamette.edu)
[2]Service for the Acropolis Monuments Restoration, Hellenic Ministry of Culture, Athens, Greece (lenalambr@hotmail.com)

Keywords: Parthenon, marble provenance, Pentelic marble

Ancient records attribute the source of the Parthenon marbles to the quarries on Mount Pentelikon some 18 km to the northwest of the Athenian acropolis. Subsequent studies by art historians, architects, archaeologists, geologists and archaeometrists have all verified the Pentelic source. Yet, our ability to gain further insight from the study of the Parthenon's construction materials does not necessarily stop there. At ASMOSIA IX, it was shown that there is a mappable pattern of stable isotope differentiation within the Pentelic quarries that allows for the identification of individual quarry pits or groups of quarry pits as the source quarries for specific elements of both the Parthenon and Propylaea. The current study further refines our understanding of quarry exploitation for the Parthenon's construction through the stable isotope analysis of 59 samples from different architectural elements and sculptural pieces of the monument. The study is further supported with the published isotope ratios of 33 samples of the Parthenon Marbles currently housed at the British Museum. The data suggests that while some elements, such as the column drums, appear to have been extracted from a variety of quarries possibly due to the required large spacing between natural joints in the rock, other quarries appear to have been targeted for specific marble uses, such as the *Aspra Marmara* quarries near the crest of the mountain which supplied marble for the sculptural program.

FORMATION OF IRON PATINAS ON ALABASTER SURFACES: SANTA MARIA DE POBLET MONASTERY, TARRAGONA, NE SPAIN

Elisabet PLAYÀ,[1] Meritxell BELTRAN,[1] Montserrat ARTIGAU,[2] Pau ARROYO,[3] Ander GUINEA[4]

[1]Departament de Geoquímica, Petrologia i Prospecció Geològica, Universitat de Barcelona (UB), Barcelona, Spain (eplaya@ub.edu; mbv103@hotmail.com)
[2]Escola de Restauració y Conservació de Béns Culturals de Catalunya (ERCBC), Barcelona, Spain (martigau@xtec.cat)
[3]Lesena Servei Integral al Patrimoni, El Vendrell, Tarragona, Spain (lesena@lesena.net)
[4]School of Science, IT and Engineering, Federation University, Victoria, Australia (a.guinea@federation.edu.au)

Keywords: Alabaster surface weathering, Iron compounds, Pyrite oxidation

Alabaster is a white and pure gypsum rock classically used in sculptures or for ornamental purposes, but such whiteness is sometimes masked by the development of scandalous reddish stains over the surface of the rock. The origin of such patinas are discussed, as they are the result of degradation processes of minerals present in alabaster rocks, contrary to what happens in the formation of most patinas.

The mineralogy of collected samples from the altarpiece was verified by means of X-ray diffraction, infrared and Raman spectroscopy. The petrographical investigation was performed on some of the objects using optical polarized light, cathodoluminescence, photoluminescence and scanning electron microscopy (equipped with backscatter image technology) microscopes.

Red-to-ochre patinas with diameters of 2-20 cm have appeared in the alabaster substrate of the main altarpiece of Santa Maria de Poblet monastery (XVI, Damià Forment). The patinas are constituted by two differentiated layers that may occur occasionally mixed. The Lower Layer contains iron compounds, which have precipitated surrounding the gypsum crystals of the rocky support and provided the characteristic red-to-ochre colour to the surface of the altarpiece. The formation of this layer was driven by the bio-oxidation, in contact with water, of the pyrite which is disseminated over the alabaster surface. The formation of this film of iron-rich particles

was conducted by a series of destructive and penetrative processes, promoting disaggregation and crystal reduction (mechanical and/or by dissolution) of the matrix minerals (gypsum, celestite, barite, calcite-dolomite…). The Upper Layer was grown by means of constructive (agglutination of particles by accretion) and destructive (destruction of the alabaster matrix and incorporation into the Layer 2) mixed processes. Thus, the presence of small crystals (1-10μm) of gypsum, quartz, calcite, celestite, barite, clay minerals and pyrite in this upper patina are mainly related to the residual products of the alabaster substrate. Moreover, some of the calcite, quartz and clay particles could also be considered atmospheric dust. Oxalates (weddellite and whewellite), portlandite and coal particles are not related to iron-rich patinas formation.

Development of the patinas probably took place after the approval of the Law of Confiscation of Religious Properties in Spain, in 1835; the monastery was abandoned and strongly damaged, and the entry of rainwater and the use of the monastery as human and animal shelter could have contributed to the presence of humidity inside the monastery, and thus initiated the pyrite oxidation. Currently, the patinas seem to be stabilized, as water is no longer in contact with the pyrites, which is needed for oxidation.

MARBLE DECORATION FROM THE LATE ROMAN PROCONSUL'S PALACE IN *SAVARIA*

Anita POLGÁR-NYERGES

Aquincum Museum BHM, Budapest, Hungary (nyerges.anita@gmail.com)

Keywords: Savaria, Late Roman, proconsul's palace, marble, fragments, making and fixing tracks, quarries

The systematic research and excavation of the ruins of the Roman *Savaria* began in 1938 and the "Járdányi Paulovics István Ruin Garden" was opened in 1943 at the area of the west side of the Roman city, near the neoclassical baroque basilica. Archaeologist István Járdányi Paulovics found the first ruins of the Late Roman proconsul's palace in *Savaria* during the excavations of the ruins garden (at first Paulovics mistakenly identified the excavated ruins as the basilica of the martyr Quirinus). The most important findings were the ruins of the palace's imperial guest-hall (*aula palatina*), where the largest dimensional mosaic remains of Pannonia were found.
The fragments of the guest-hall's marble decoration can be found in the collection of the Savaria Museum (Szombathely). Unfortunately, numerous marble fragments are stray finds and the fragments became intermixed in the museum. Systematic research of marble fragments of the proconsul's palace began in 2013. The primary scientific elaboration was the stock-taking and the identification (primaeval place, function) of the fragments. The reviewed finds have varied pictures; the fragments have diverse forms and colours. We were able to separate some large face-stones with rhombus and rectangle forms, small and colourful frame brackets and fragments of profiled door and window frames. We were able to observe the tracks of the making (chisel traces) and the fixing (hole pressures and the tracks of the iron claps) on numerous fragments. The comparison of the marble fragments of the proconsul's palace with those of *Savaria* (for example the marble carvings of *Iseum*) is an important part of the research. Hypothetically speaking, on the basis of the marble carvings of *Iseum* we may expect that the marble decoration of the proconsul's palace could have come from the antique marble quarries of Austria (Carinthia territory).

A NEW ROMAN IMPERIAL RELIEF SAID TO BE FROM SOUTHERN SPAIN: PROBLEMS OF STYLE, ICONOGRAPHY, AND MARBLE TYPE IN DETERMINING PROVENANCE

John POLLINI,[1] Pilar LAPUENTE,[2] Jerry PODANY[3]

[1]University of Southern California, Los Angeles, California, United States (pollini@usc.edu)
[2]University of Zaragoza, Zaragoza, Spain (plapuent@unizar.es)
[3]J. Paul Getty Museum Conservation, Los Angeles, California, United States (jpodany@getty.edu)

Keywords: Tiberius, Spain, Carrara

An important but thus far little known large, very fine grained white marble historical relief, featuring three figures and part of a Latin inscription, is said to be from Southern Spain. This privately owned relief, presently on loan to the J. Paul Getty Museum, represents the Emperor Tiberius (identifiable by portraiture and the inscription) being introduced by a female personification (probably Concordia) to an enthroned semi-nude figure holding a cornucopia (presumably the *Genius* of the People). This paper examines the style, iconography, and marble type of the relief in an attempt to determine if it indeed originally may have come from Southern Spain, especially from a prominent city, given the high quality of the carving. Various factors suggest that the relief was carved either by a sculptor trained in a workshop in Rome or by a local artist who himself had been trained by a Rome-based sculptor.

Two marble samples taken from the relief, as well as the unpublished preliminary isotopic analyses provided by Jerry Podany of the J. Paul Getty Museum Conservation, were further analyzed in detail by Pilar Lapuente in the Department of Earth Sciences of the University of Zaragoza. This was done in order to determine whether the white marble was from the Luni-Carrara quarries of Italy, as suggested by the initial isotopic analyses, or whether the marble might be of Spanish origin, especially from the quarries of the Lusitanian Estremoz Anticline or the Baetican Almadén de la Plata districts, both of which were used in the SW part of Roman Hispania, but were generally not widely exported elsewhere, as far as we know. Based on the combined petrographic (MGS<0.6 mm in length),

cathodoluminescence (CL), and a C and O Isotopic analysis, the marble proved to be a calcitic marble from the Luni-Carrara quarries. This prestige marble from Italy was used in Roman Hispania for different decorative sculptural programs, especially those of the Augustan and Julio-Claudian period, as we know, for example, from the study of sculpture from Mérida. This paper points up the various problems associated with our evidence, as well as its limitations, in attempting to determine where and when such unprovenanced marble sculptures were produced and employed in ancient Roman times.

AN INVESTIGATION OF GILDING, REPAIRS AND RESTORATIONS: THE CASE STUDY OF A PORTRAIT OF ANTINOUS IN THE SAN ANTONIO MUSEUM OF ART

Jessica POWERS,[1] Mark ABBE,[2] Michelle BUSHEY,[3] Scott H. PIKE[4]

[1]San Antonio Museum of Art, San Antonio, Texas, United States (jessica.powers@samuseum.org)
[2]Lamar Dodd School of Art, University of Georgia, Athens, Georgia, United States (abbe@uga.edu)
[3]Department of Chemistry, Trinity University, San Antonio, Texas, United States (mbushey@trinity.edu)
[4]Department of Environmental and Earth Sciences, Willamette University, Salem, Oregon, United States (spike@willamette.edu)

Keywords: polychromy, gilding, restoration

This paper presents results of an interdisciplinary investigation into the gilding and ancient and post-antique interventions on a marble portrait head of Antinous in the San Antonio Museum of Art. The head presumably once belonged to an over-life-size statue of Hadrian's companion, standing in the so-called "Apollo Lykeios" pose, with the right hand resting on the head, and wearing an ivy wreath. In 2011 we discovered evidence for gilding, not previously documented, on the ivy wreath. Our investigation has focused on understanding the relationship of the gilding to areas of purple coloration on the marble surface. Surface examination and laboratory analysis of samples have revealed that the purple layer is composed of gold nanoparticles resulting from the deterioration of the gilding. In previous scholarship, such purple areas have often been mistaken for pigment or preliminarily identified as the remains of an organic adhesive. Our results thus form an important contribution to the understanding of ancient techniques for the gilding and polychromy of marble sculptures. We further situate these results within the historical context of the distinctive range of coloration on other Roman marble sculptures from the first half of the second century AD.

Through surface examination, our study has shed light on previously undocumented aspects of ancient and post-excavation interventions into the head's appearance. We have critically reassessed H. Meyer's argument (in *Antinoos* [Munich, 1991], 128) that the head was recut in antiquity from a

statue of Dionysos and have documented further evidence for ancient reworking. The post-excavation treatments included restoration of damaged and missing features, multiple phases of cleaning and application of coatings to the surface, and ultimately removal of the restorations. The head, first published in 1984, is thus revealed to have a long and complex post-antique history.

The head was examined with optical microscopy and UIL and VIL imaging. Following in situ XRF, samples of the gold nanoparticles, adhesives and surface coatings were characterized with SEM, PLM, Raman spectroscopy, and FTIR spectroscopy. In addition, stable isotope analysis of a marble sample taken from the head coupled with macroscopic observations of the marble's texture suggest a Pentelic provenance. Our combined analysis of the marble-working techniques, polychrome effect, and marble type allow us to propose a plausible historical narrative for this distinctive head's creation.

AURISINA'S LIMESTONE IN THE ROMAN AGE: FROM KARST QUARRIES TO THE CITIES OF THE ADRIATIC BASIN

Caterina PREVIATO

Dipartimento dei Beni Culturali, Università degli Studi di Padova, Padua, Italy
(caterina.previato@unipd.it)

Keywords: Aurisina, quarries, Roman age

Aurisina's limestone is a stone extracted in the Karst region, in a basin situated just a few kilometers from Trieste. This stone has been largely used in the Roman age because of its aesthetical and physical qualities. The Aurisina's quarries, situated in Aquileia's territory and under the control of the city, were exploited at least from the 1st century B.C. They provided a huge quantity of stone that was used for buildings and infrastructures as well as for decorative elements and different kinds of artifacts (statues, inscriptions, weights, etc.).

This paper aims at reconstructing the different stages of the production process of Aurisina's limestone, analyzing different topics that are quarrying, transport, diffusion and use of this stone in the cities of North Italy and of the Adriatic basin.

On the one hand, the attention is focused on Aurisina's quarries, attempting to define exploitation dynamics in the Roman age, as well as to reconstruct transport logistics from quarries to building sites.

On the other hand, the attention is focused on structures, infrastructures and artifacts made of Aurisina's limestone and found in the cities of North Italy and of the Adriatic basin that will be considered to reconstruct commercial fluxes and to understand the economic role of Aurisina's extraction basin in the Roman age.

QUARRYING, CIRCULATION AND USE OF STONE DURING THE ROMAN AGE: A DATABASE AND GIS PROJECT ABOUT *REGIO X - VENETIA ET HISTRIA*

Caterina PREVIATO, Arturo ZARA

Dipartimento dei Beni Culturali, Università degli Studi di Padova, Padua, Italy
(caterina.previato@unipd.it;arturo_zara@alice.it)

Keywords: Regio X, quarries, Database/GIS

Since 2009 the University of Padova has developed a research project concerning the quarrying, the circulation and the use of stones extracted in *Regio X* (*Venetia et Histria*) during the Roman age. The research, in pursuance of a multi-disciplinary approach, will lead to a reconstruction of historical and economical scenarios that revolved around the supply and use of the stones of this area.

On the one hand, the project consists in taking a census of the ancient quarries of *Regio X*, in order to identify the natural resources exploited in the Roman age. On the other hand, it aims at studying and registering artifacts, structures and infrastructures made of stones extracted in this region. Reaching these goals required the development of a database that links extraction basins and related quarries, artifacts and structural elements, as well as samples taken from archaeological finds and from quarries.

Until now, the attention has been focused on Euganean trachyte (Venetian Volcanic Province) and Aurisina's limestone (Trieste Karst), and the research has been carried out by means of published and unpublished data, both about quarries and archaeological finds.

Thanks to the integration of the database with a GIS mapping software, it has been possible to realize interesting reconstructions of commercial fluxes of stones extracted in *Regio X*, useful for a better understanding of the economical relationships between ancient cities and surrounding territories.

ANALYTICAL PROTOCOL FOR THE PROVENANCE DETERMINATION OF OPUKA - A CLAYEY CALCITE - RICH SILICEOUS MUDSTONE USED SINCE ANTIQUITY IN BOHEMIA

Richard PŘIKRYL,[1] Zuzana WEISHAUPTOVÁ,[2] Martin RACEK,[3] Jiřina PŘIKRYLOVÁ[4]

[1]Institute of Geochemistry, Mineralogy and Mineral Resources, Faculty of Science, Charles University in Prague, Prague, Czech Republic (prikryl@natur.cuni.cz)
[2]Institute of Rock Structure and Mechanics, Academy of Sciences of the Czech Republic, Prague, Czech Republic (weishauptova@irsm.cas.cz)
[3]Institute of Petrology and Structural Geology, Faculty of Science, Charles University in Prague, Prague, Czech Republic (martin.racek@natur.cuni.cz)
[4]Academy of Fine Arts in Prague, Prague, Czech Republic (jirina.prikrilova@avu.cz)

Keywords: Opuka/Mudstone, Analytical protocol, Provenance studies

Opuka is a non-genetic term denominating very fine-grained sedimentary rocks deposited during Upper Cretaceous in relatively shallow (hemipelagic) marine conditions. Accessibility of outcrops close to the ancient settlements in Bohemia and ease of workability of some opuka varieties lead to their adoption in architectural and sculptural projects even in antiquity when the Bohemian territory was inhabited by Celtic tribes (a head of a Celtic hero, deposited in the Czech National Museum, carved from opuka presents one of the most precious artefacts of this period). From about the 9th c. AD, opuka stones were employed as a common constructional stone, but specifically during Gothic they were widely used as a highly valued sculptural stone for polychromous Madonnas of the so-called beautiful style.

The source localities (abandoned quarries) occur at many places within the recent outcrops of the Bohemian Cretaceous basin and linking the stone of artefacts to specific quarries is extremely difficult as variable amounts of silica, carbonates (calcite), clay minerals, and microfossils can occur even in specimens sampled within one quarry. Past petrographic classifications introduced some incorrect denominations of opuka stones resulting in their confusing petrographic ranking. The recent study aims to introduce a complex analytical protocol of opuka stones which should facilitate both their

petrographic classification and correct determination of possible source area of specimens from artefacts.

The study is based on petrographic examination of several tens of artefacts and of specimens from abandoned quarries. The analytical protocol consists of four sets of techniques: (1) microscopic observation (basic optical microscopy supplemented with the electron microscopy with microanalysis and X-ray elemental mapping), (2) X-ray diffraction and FTIR spectrometry of insoluble residue (composition of clay fraction and detection of some less organized silica forms), (3) chemical analysis and computation of modal composition by using normative minerals based on known mineralogical composition (input from microscopy and XRD), (4) study of physical properties, specifically by means of mercury porosimetry to quantify complex pore space of these rocks.

Based on the results, a new petrographic classification of opuka stones is proposed, based on the proportions of various forms of silica as a major component, and carbonates and clay minerals as a subordinate component. In general petrographic sense, opuka ranges to a mudstone family; most of the studied rocks belong to siliceous mudstone. In respect to analytical protocol for source area determination, the most valuable data are obtained from X-ray elemental mapping, X-ray diffraction of insoluble residue, and from porosimetric studies.

UNRAVELING THE CARRARA – GÖKTEPE ENTANGLEMENT

Walter PROCHASKA,[1] Donato ATTANASIO,[2] Matthias BRUNO[3]

[1]Department of Applied Geological Sciences and Geophysics, University of Leoben, Leoben, Austria (walter.prochaska@unileoben.ac.at)
[2]Istituto di Struttura della Materia, Consiglio Nazionale delle Ricerche (ISM-CNR), Rome, Italy (donato.attanasio@ism.cnr.it)
[3]Via dei Vascellari 34, Rome, Italy (matthiasbruno@libero.it)

Keywords: Göktepe marbles, Sr-content, trace element analysis

The systematic investigation of imperial portraits from the 1st century AD up to late antiquity revealed a dramatic change in the portrait marbles starting approximately in Trajanic times. By the beginning of the 2nd century a so far unknown marble of exceptional quality suddenly arrived in Rome and became the portrait marble par excellence. Another paper presented in this conference demonstrates the provenance and use of portrait marbles throughout the imperial times. Through all the imperial period Göktepe marbles account for almost 50% of the portraits investigated, second comes Lychnites, followed by Carrara. Until a few years ago, the corresponding quarries of this marble in Western Anatolia close to Göktepe in the area of Aphrodisias were unknown and innumerable artifacts of prime importance made of this marble were taken for Carrara marble.

This paper deals with the presentation of the petrographical and chemical characteristics of the Göktepe marbles, their similarities and differences to the Cararra marble and discusses the cause of the Carrara-Göktepe entanglement. The macroscopic features of the Göktepe marble are very similar to other high quality marbles used in antiquity and resemble very much the characteristics especially of Carrara marbles. The isotopic similarities and the partial overlap of the corresponding isotopic fields were the reason that the isotopic field of Carrara marble used so far was oversized and the existence of another even more important portrait marble was not realized. The isotope composition alone does not discriminate sufficiently and so we looked for other particular analytical characteristics for unambiguous archaeometrical identification. Trace element contents, namely low Fe, Mn and homogenous and exceptional high Sr numbers, discriminate the Gök-

tepe marbles perfectly against Carrara marbles. Characteristic differences in the trace mineral contents of these marbles are also presented.
The discovery of the existence of a so far unknown marble of utmost importance contributed essentially to the knowledge of the marbles used in Roman times throughout the whole empire. The production of fine-grained white marble of highest quality used exclusively for portraits is attested from the mid of the 1st century AD until advanced late antiquity. The petrographic and chemical features of the Göktepe and Carrara marbles presented in this paper allow an unambiguous discrimination of these marbles which, among these from Göktepe, were in fact the most important portrait marbles of Roman Antiquity.

THE MARBLES OF THE SCULPTURES OF FELIX ROMULIANA IN SERBIA

Walter PROCHASKA,[1] Maja ŽIVIĆ[2]

[1]Department of Applied Geological Sciences and Geophysics, University of Leoben, Leoben, Austria (walter.prochaska@unileoben.ac.at)
[2]National Museum Zaječar, Zaječar, Serbia (majazivicnika@yahoo.com)

Keywords: Felix Romuliana, sculptural inventory, marble provenance

Located south of the Danube River, near the city of Zaječar in the vicinity of Gamzigrad the palace of Galerius is one of the most important late Roman Imperial sites in SE Europe. The place is considered to be the birthplace of emperor Galerius who built the palace as a retirement residence at the end of the 3rd century. The operating life of the palace was relatively short thus giving a good chronology of the investigated marble artefacts.
Within the course of a campaign in 2012, a series of marble sculptures were sampled in order to determine the provenance of the marbles to elucidate the marble production centres and trading relations of this period. Microsamples were taken from broken and non-worked surfaces of the sculptural fragments and analysed for their petrographic and chemical characteristics. Besides the standard petrographic analysis with the petrographic microscope, stable isotopes, trace elements and the chemical composition of microinclusions were performed. The resulting big number of variables requires a multivariate statistical analysis in combination with our databank of ancient marble quarries in the Roman Empire.
All marbles investigated are white and of very good quality. Grain size in most cases is below 1mm and only a few sculptures of medium to coarse-grained marbles were found. Two groups of fine-grained marbles were found. The first is of remarkable homogenous composition and resembles the characteristics of Dokimean marble. The similarity in the composition of these marbles suggests an origin from one and the same Dokimean quarry for this group of statues. The other group shows lighter O-isotope composition and all the analytical parameters match Pentelic marbles.
Three sculptures of medium to coarse-grained marbles yet cannot be safely attributed to a source and indications of a provenance from Thracian marble quarries are presently being investigated.

IDENTIFICATION OF AN ANCIENT LIMESTONE QUARRY ON THE IONIAN COAST OF SOUTHERN APULIA (SOUTHERN ITALY): ROCK CHARACTERIZATION AND NEW DATA ABOUT ITS EXPLOITATION OVER TIME

Giovanni QUARTA,[1] Maria Teresa GIANNOTTA,[1] Francesco GIURI,[1] Paolo SANSÒ,[2] Andrea VITALE[2]

[1]IBAM-CNR, Institute for Archaeological and Monumental Heritage - National Research Council, Lecce, Italy
(g.quarta@ibam.cnr.it; mt.giannotta@ibam.cnr.it; f.giuri@ibam.cnr.it)
[2]Di.S.Te.B.A. - Università del Salento, Lecce, Italy
(paolo.sanso@unisalento.it; vitaleandrea@inwind.it)

Keywords: Puglia region, ancient coastal quarry, limestone, UAV survey, late olocene coastal evolution

Along the Ionian coast of southern Apulia many ancient quarries have been identified. In most cases, stone materials were extracted in ancient times from calcarenite outcrops to be used for local monuments or to be traded in the nearby Basilicata region. Some limestone quarries have been identified along the same coastal area, but data obtained in situ would not indicate their exploitation in ancient times.

In this paper the results of an integrated research carried out on a limestone quarry located near the Ionian coastline of southern Apulia, about 70 km south of Taranto (the ancient Tarentum) and a few kilometers east of Nardò village (the ancient Neretum), are reported.

The morphological characteristics of the coastal area, the size of the squared blocks still found in situ and the presence of peculiar excavation marks would suggest an ancient exploitation of the quarry even if other mining activities up to the 19th century cannot be excluded.

A photographic and topographic survey of the quarry area by means of an unmanned aerial vehicle (UAV) was carried out, the geological and geomorphological characteristics defined and the lithological and petrographic properties of quarry material analyzed as well.

The reconstruction of the quarry's 3D model allowed its extent and the volume of the extracted material to be estimated. Since a part of the quarry is placed below present sea level, geomorphological analysis could fix some

chronological constraints of its exploitation time range. Finally, the d mineralogical and petrographic characterization of the quarry stone would be useful for identifying these materials if they were used for local monuments.

SOURCING THE STONE. PRELIMINARY RESULTS OF A PROVENANCE STUDY IN A STONELESS LANDSCAPE

Sibrecht RENIERE,[1] Veerle CNUDDE,[2] Roland DREESEN,[3]
Eric GOEMAERE,[3] Wim DE CLERCQ[1]

[1]Department of Archaeology, Historical Archaeology Research Group (HARG), Faculty of Arts and Philosophy, Ghent University, Ghent, Belgium (Sibrecht.Reniere@Ugent.be; w.declercq@ugent.be)
[2]Department of Geology and Soil Science, Faculty of Sciences, Ghent University, Ghent, Belgium (Veerle.Cnudde@UGent.be)
[3]Royal Belgian Institute of Natural Sciences, Geological Survey of Belgium, Brussels, Belgium (roland.dreesen@telenet.be; egoemaere@naturalsciences.be)

Keywords: provenance, stone tools, stoneless landscape

This paper presents the preliminary results of an ongoing PhD project and highlights the fruitful collaboration between archaeologists and geologists. The project focuses on the material culture of stone artefacts (millstones, whetstones, cosmetic and medicine plates, etc.) during the Roman period in the Civitas Menapiorum. The civitas was situated on the northern border of the Roman province of Gallia Belgica and is now covered by the current Belgian provinces of East- and West-Flanders and of the Dutch province of Zeeland. Geologically it is characterized by a quasi absence of natural stone outcrops suitable for use in domestic context. Yet stone was used in every-day activities such as grinding and whetting, implying its import as a finished or semi-finished product from regions outside the civitas. The main objective of our project is to unravel the provenance, the product supplies/distribution networks and the use of the stone artefacts within a broad interpretative framework, taking into account spatial, technological, typological, chronological and socio-economical factors.

In the poster we are focusing on the geological and geographical provenances of the raw geo-materials. Their identification has been based on a detailed lithological study through macro-, meso- and microscopic observations. Petrographic analysis of thin sections was used to fine-tune on a microscopic level. For particular rock types geochemical analysis (XRF) was needed. As a result, (litho-) stratigraphic assignments as well as geological-geographical provenances have been suggested for the identified geo-materials.

A broad spectrum of natural geo-materials has already been identified: conglomerates, sandstones, arkoses, siltstones, limestones and volcanic rocks (vesicular lava) derived from *Cambrian* (*Revinian*), *Lower* and *Middle Devonian* (*Lochkovian*, *Eifelian*) and *Tertiary* strata (*Landen formation*). The provenance areas are all located within Northern France, the center of Belgium, Southern Belgium and Western Germany.
Studying artefacts provenances and distributions in relation with qualitative contexts will provide further insights into the socio-economic processes of these local 'Gallo-Roman' communities and their networks within the wider context of the northern parts of the Empire.

BUILDING MATERIALS AND THE ANCIENT QUARRIES AT *THAMUGADI* (EAST OF ALGERIA), CASE STUDY: SANDSTONE AND LIMESTONE

Younes REZKALLAH,[1] Ramdane MARMI[2]

[1]Ecole doctorale d'archéologie, Université de Paris1 Panthéon-Sorbonne, Paris, France (younes.rezkallah@gmail.com)
[2]Laboratoire Géologie et Environnement, Université de Constantine 1, Constantine, Algeria (marmi_ramdane@yahoo.fr)

Keywords: Building materials, Quarries, Petrography, Thamugadi

This research deals with the study of two types of building materials (sandstone and limestone) used in the Roman city of *Thamugadi* founded in 100 AD (actual Timgad, East of Algeria), and the ancient quarries from which they had been extracted.

It aims to identify these stones through archaeological surveying and sampling in the archaeological site, where we need to identify their use, and in the ancient quarries which existed near *Thamugadi* (inside a perimeter of 15 km) so that we can find out their provenance.

The archaeological site itself and its monuments are well studied, and one can find a lot of bibliography about them, but that is not the case for the building materials. Moreover, the ancient quarries remain unknown till the present work, and have never been studied.

It was important to study these two types of stones most used as building materials, in order to collect and provide new data, particularly for this region of the Roman Empire where the few researches already done in that field focused only on some Marble and Marble quarries.

The petrographic study of rocks (mineral composition, structural fabric and fossils contents) allowed us to identify that two kind of sandstone were used in *Thamugadi* (fine grained and coarse grained), both of them belonging to the Miocene. Limestone is usually identified by its faunal content that belongs to the Turonian.

By comparison of materials from one part of the archaeological site and also the surrounding rock outcrops, we were able to locate the possible extraction sites. Fourteen quarries were identified, five of them furnished stones to the city: Djelfaoune for coarse sandstone, Mechta Rebaa for fine

sandstone; Medjeba, Lerdham, Elghar Nithviren for the limestone. The petrographic results and the archaeological evidences combined together allowed us to conclude that the hardness and beauty of limestone, explains its use for paving of the two main streets of the city, and the most important monument as the Forum, while the sandstone was used for building purpose and paving secondary streets.

THE VALUE OF MARBLE: CONTEXTS OF REUSE OF ARCHITECTURAL MATERIALS IN LATE ANTIQUE SEVILLE (GOYENETA, 17). ARCHAEOLOGICAL ANALYSIS AND PETROGRAPHIC CHARACTERIZATION

Oliva RODRÍGUEZ,[1] Esther ONTIVEROS,[2] Luisa LOZA,[2] Ruth TAYLOR,[1] José BELTRÁN,[1] Araceli RODRÍGUEZ[3]

[1]Departamento de Prehistoria y Arqueología, Universidad de Sevilla, Seville, Spain (orodriguez@us.es; ruth.taylor@hotmail.com; jbeltran@us.es)
[2]Instituto Andaluz del Patrimonio Histórico, Junta de Andalucía, Seville, Spain (Esther.ontiveros@juntadeandalucia.es; Marial.loza@juntadeandalucia.es)
[3]Archaeologist, Arqueología & Gestión, S.L., Seville, Spain (araceli_azogue@hotmail.com)

Keywords: Marble characterization, archaeometry, Roman Seville, reuse building materials

Despite the large number of preventive archaeological excavations carried out in recent decades in the urban area of the city of Seville, there have been very few contextualized finds of larger architectural elements. The necessary monumentality of ancient *Hispalis* (the name of the Roman colony), particularly in the area identified as the heart of the city and the centre of public activities, is limited to a few *disiecta membra* preserved in modern buildings and locations that are uninformative about their original use.

In this context, the assemblage of materials recovered *in situ* during the excavations at 17 Goyeneta Street is of particular interest. The information that they provide is twofold: first, on the typology, monumentality and nature of the elements, the materials which are the object of a detailed analysis in this study; second, on the reuse of this assemblage of Roman architectural elements of considerable scale in a Late Antique building. This assemblage therefore provides insight not only into the monumentality of the city of the High Empire but also into the processes undergone by the city in later centuries, some of which have already been documented through the work on the nearby site of Plaza de la Encarnación.

This study presents the first petrographic and chemical characterization of the raw materials used in this assemblage, among which there is an interesting combination of regional stones (Almadén de la Plata, local mylonitic and oolithic limestones) and imported marble (Luni), arranged on the basis of carefully studied colour schemes.

COLOURED *MARBLE* PANELS FROM THE *THERMAE* OF CARNUNTUM (AUSTRIA)

Andreas ROHATSCH,[1] Barbara HODITS,[1] Beatrix MOSHAMMER[2]

[1] Research Center of Engineering Geology, Institute of Geotechnics, Vienna University of Technology, Vienna, Austria (andreas.rohatsch@tuwien.ac.at; barbara.hodits@tuwien.ac.at)
[2]Geologische Bundesanstalt, Fachabteilung für Rohstoffgeologie, Vienna, Austria (beatrix.moshammer@geologie.ac.at)

Keywords: Carnuntum, marble, decorative stones, petrography, provenience

During the last 100 years of archaeological research in Carnuntum several thousand fragments of decorative *marbles*, used for indoor panelling in representative public buildings, were collected. Precious decorative stones as items of luxury reflect the trading relations among the provinces of the Roman Empire.

Considerations on the transport of the roughly shaped raw material blocks from the quarries to the construction sites are presented. This includes the modes of their further and final treatments, like sawing, grinding and polishing.

Present-day names of popular marbles are based on Faustino Corsi´s (1825) description and collection. In the context of our study the terms refer, as far as possible, to Plinius. Due to petrographic examinations, supplemented by several published data, several rock types including *lapis Lacedaemonius, l. porphyrites*, *marmor Sagarium, l. Alabastrites, m. Carystium, m. Numidicum, m. Carium, m. Greco scritto, m. Docimenium, m. Scyreticum, m. Lunensium, m. Lychnites* and *m. Alpinus* have been identified. For characterizing and evaluating the mentioned rock type inventory, we studied their structural and textural properties as well as their mineralogical compositions and applied handheld XRF-spectrometry to test their geochemistry with regard to certain major and trace elements.

The results of the presented investigation show impressive trading connections between Carnuntum and faraway provinces of the Roman Empire in the Mediterranean. In particular, evidence was found for rock sources situated in Italy, Greece, Turkey, Egypt and Tunisia.

MARBLES DISCOVERED ON THE SITE OF THE FORUM OF VAISON-LA-ROMAINE (VAUCLUSE, FRANCE): PRELIMINARY RESULTS

Elsa ROUX,[1] Jean-Marc MIGNON,[2] Philippe BLANC,[3] Annie BLANC[4]

[1]IRAA Université Aix-Marseille, Aix-en-Provence, France (elsa.roux.89@gmail.com)
[2]Direction de la Culture, Département Vaucluse, Avignon, France (mignon-jm@cg84.fr)
[3]Sorbonne Universités UPMC, Paris, France (philippe.blanc@upmc.fr)
[4]Sorbonne Universités LAMOP, Paris, France (philippe.blanc64@sfr.fr)

Keywords: White marble, coloured marble, inscription, slabs, ornamental elements, forum

Since May 2013, during the new archaeological excavations at the forum of *Vasio Vocontiorum*, archaeologists have discovered a large amount of marble slabs, fragments, ornamental and architectural elements on both white marble and limestone, as well as many inscriptions on white marble slabs, and fragments of sculptures.

The decoration is currently under study; it includes the main coloured marbles of the Mediterranean basin: green and red porphyry, *Africano*, *Cipollino verde* (Euboea), *fior de pesco* (Eretria), *Breccia pavonazzetto* (Synnada), *Giallo antico* (Chemtou), *Bardiglio* from Carrara, and some fragments of *Verde antico*, from Thessaly.

Four sources of white marble have been identified: Carrara, Penteli, Proconnesus and Thassos. The dolomitic marble of Thassos is never used in Gaul for architectural elements, but in Vaison, it was used for some inscriptions as well as for wall decoration – the slabs were either left unornamented or sculpted, as the bas-relief with the lionesses.

The rich decoration of the forum fits in harmoniously with those of the Roman *villae* and thermal baths of the city.

UPDATED CHARACTERIZATION OF THE WHITE AND GREYISH SAINT-BÉAT MARBLES. PARAMETERS OF ITS DISCRIMINATION FROM CLASSICAL MARBLES

Hernando ROYO PLUMED,[1] Pilar LAPUENTE,[2] José Antonio CUCHÍ,[3] Mauro BRILLI[4]

[1]Institut Català d'Arqueologia Clàssica (ICAC), Tarragona, Spain (hroyo@icac.cat)
[2]Área de Petrología y Geoquímica, Departamento de Ciencias de la Tierra, Universidad de Zaragoza (UNIZAR), Zaragoza, Spain (plapuent@unizar.es)
[3]Escuela Politécnica Superior, Universidad de Zaragoza (UNIZAR), Huesca, Spain (cuchi@unizar.es)
[4]Istituto di Geologia Ambientale e Geoingegneria, Consiglio Nazionale delle Ricerche (IGAG-CNR), Rome, Italy (mauro.brilli@igag.cnr.it)

Keywords: Pyrenean marbles, petrological parameters, isotopic analysis

Saint-Béat marble is considered by archaeomaterial researchers to be one of the most recognized Roman Gaul marbles. The quarries are located beside the village of Saint-Béat (Department of Haute-Garonne, Midi-Pyrénées), in the Central French Pyrenees, and are well communicated with ancient Gaul by the large valley of the Garonne River. White and greyish varieties were exploited at Roman times and used in sculpture, architecture and epigraphy mainly in Southern *Gallia*, but were also extended beyond the *Hispanic* border.

On the other side of the Pyrenees (ancient *Tarraconense* Roman *Hispanic* province), the lack of local marble quarries did not impede the use of this noble material as part of the decorative programmes of private and public Monuments. Furthermore, the favourable geographical location of the Ebro Valley, open to the Mediterranean Sea, enabled the entrance of classical marbles from all around the Mediterranean. Therefore, the provenance study of Roman marble artefacts found in this *Hispanic* territory requires a clear distinction between the classical and the French Pyrenean marbles. This contribution aims to highlight the most useful parameters that serve to discriminate Saint-Béat marbles from other classical varieties. A multimethod approach combining optical microscopy (OM), cathodoluminescence (CL) and stable C and O isotope analysis was applied to samples collected at the open-cast quarries of both banks of the Garonne River, Cap du Mont and Mont Rié, that became well known after the studies

published two decades ago. The new collection of samples with white, bluish-grey and banded in white and grey not only ratifies the lithotypes previously recognized but redefines the petrographic parameters using both OM and CL analysis and delimitates the isotopic signature. This updated characterization has been successfully checked with Roman artefacts from different archaeological sites of the *Tarraconense* province.

WHITE AND GREY MARBLES IN ROMAN AND LATE ANTIQUITY TIMES IN THE PROVINCE OF TOLEDO (SPAIN). ARCHAEOMETRIC CHARACTERIZATION

Hernando ROYO PLUMED,[1] Anna DE MESA,[2] Mauro BRILLI[3]

[1]Área de Petrografía y Geoquímica. Departamento de Ciencias de la Tierra. Universidad de Zaragoza (UNIZAR), Zaragoza, Spain (hroyo@icac.cat)
[2]Unitat d'Estudis Arqueomètrics, Institut Català d'Arqueologia Clàssica (ICAC), Tarragona, Spain/Department de Ciències de la Antiguitat i l'Edat Mitjana, Universitat Autònoma de Barcelona (UAB), Bellaterra, Spain (ademesa@icac.cat)
[3]Istituto di Geologia Ambientale e Geoingegneria, Consiglio Nazionale delle Ricerche (IGAG-CNR), Rome, Italy (mauro.brilli@igag.cnr.it)

Keywords: white marbles, Toletum, archaeometry

Within the context of the study of Hispanic stone materials, characterization, identification, distribution and use of ornamental stones used in Roman times, has been widely developed; while the study of the location of the exploitation fronts, has unevenly developed in Spain. Thus, there are regions of the Peninsula that lack systematic studies on this line of research. This is the case of the province of Toledo, where geological papers abound, but attention towards exploitation in ancient times is still scarce. However, since 2009, we have been studying the localization, characterization and dissemination of granites and limestones used in *Toletum* and its immediate surroundings. Now we continue this line of research by presenting the location of quarries of white and grey marbles as well as the complete characterization of its different varieties.

Marble outcrops in this region are located in the outer limits of Complejo Anatéctico of Toledo (CAT), geological context of the preliminary study of granites and limestones, nearby two towns with Roman past: *Caesarobriga* (current Talavera de la Reina) and *Consabura* (Consuegra); and in two villages with a possible foundation in late Antiquity or Middle Ages: Urda and Mora.

These populations have continued stonework activity until today, so the existence of old fronts is not known. However, recent studies have been able to change the traditional view that the white marbles used in this central region were all of non-Hispanic origin, due to the absence of documented local white marbles until quite recently.

Therefore, the correct characterization of these local marbles by archaeometric studies (POM, CL and IRMS for CO isotopic determination), provides a better understanding about its use next to other Hispanic materials and classic marbles. In parallel, since the province of Toledo is rich in archaeological heritage, a thorough archaeometric characterization will allow in the future: a greater understanding of the impact of the exploitation of natural resources in the area; confirm or rule out distribution to a larger scale; use and transportation for monumentalization from nearby towns, along with other traditional materials in Roman times; and infer the changes or permanencies of these materials in subsequent periods for ornamental use.

REVETMENTS FROM COLONIA ULPIA TRAIANA, XANTEN (GERMANY)

Vilma RUPPIENĖ

Institut for Geography und Geology, University of Wuerzburg, Wuerzburg, Germany
(Vilma_ged@hotmail.com)

Keywords: Colonia Ulpia Traiana, marble revetments, provenance

Colonia Ulpia Traiana (CUT) was founded at the beginning of the 2nd century AD by Emperor Trajan. Administratively, it belonged to the Roman province Germania Inferior. In the ruins of different public buildings and private homes of CUT ca. 3250 fragments of former wall and floor revetments were discovered. The major share of slabs belonged to the interior decoration of the public buildings such as Harbour temple, Capitolium, public baths and the forum. Only a few fragments were discovered in private homes.

As CUT had no local quarries producing decorative stones, its needs for stones had to be covered by import from regional or foreign sources. Therefore, the first aim of this study was to characterize and to determine the types of stones used in the buildings of CUT with the help of petrographic (thin sections, XRD), chemical (XRF spectroscopy) and isotopic analysis ($_{18}$O and $_{13}$C), in order to identify their provenance.

The other goal was to document the variety of stones used for incrustations. Were there differences in the choice of material in the buildings of CUT? Were public and private buildings decorated with the same stone types as the public buildings of Rome? Or were regional stones preferably used in order to save high transportation costs?

The investigations revealed that more than 40 different types of decorative stones were used in CUT. Most of the stones (ca. 80%) are of Mediterranean origin. The most common are Fior di pesco, Breccia di Sciro, Cipollino verde, Pavonazzetto, Rosso antico, Rosso Iassense, Verde antico, Porfido verde antico, Porfido rosso, Breccia corallina, Greco scritto, Pentelic, Carrara, Proconnesian, dolomitic Thasian marble and others. Few types of stone were imported from French quarries: Lutetian limestone, Jurassic limestone from the Norroy quarries and Pierre de Pouillenay.

Regional stones were also exploited and used by the Romans for decorative purposes, but to a lesser extent than Mediterranean stones: course grained marble from Odenwald, trachytes from Drachenfels near Bonn and from Berkum/Wachtberg, red Belgian limestones, Kohlenkalk from Aachen and some Belgian sources.
The choice of decorative stones was clearly different concerning particular public buildings. Every building was embellished with a varying spectrum of marbles. In some objects like the forum, the assortment of stones was chosen based on examples from Rome (preferred use of Pavonazzetto). Unlike the forum, Harbour temple was preferably decorated with Fior di Pesco, which is not affirmed in any public building of Rome. Incrustations in the baths of CUT consisted primarily of regional Kohlenkalk, Lutetian limestone and Pentelic marble.

LABOUR FORCES AT IMPERIAL QUARRIES

Ben RUSSELL

University of Edinburgh, Edinburgh, United Kingdom (ben.russell@ed.ac.uk)

Keywords: Quarries, imperial control, labour, ostraka

This poster will explore the question of manpower at imperially-administered quarrying sites. Drawing on the evidence provided by the *ostraka* at Mons Claudianus and other quarries in the Eastern Desert of Egypt, the manpower totals at different periods will be analysed. The key document here is the well-known water list (*O.Claud.* inv. 1538, 2921), which gives detailed information about the numbers of workers responsible for different tasks in the quarries in the mid Trajanic period (c. AD 110) (Cuvigny 2005, 310-20; Bülow-Jacobsen 2009, 263-6). This *ostrakon* and others comprising draft letters between workers and their supervisors can be used to reconstruct working practices and labour organization. These data will then be compared with what is known of quarrying elsewhere, notably at the major quarries at Dokimeion in Phrygia and Simitthus in North Africa. While direct evidence for the individuals involved in the extraction of stone at these sites is not as forthcoming as for the Eastern Desert sites, certain conclusions can be drawn from the surviving quarry inscriptions and, in particular, the references to *officinae* and *caesurae* (on which, Fant 1989; Christol and Drew-Bear 1991; 2005; Hirt 2010). Data from these epigraphic sources will then be set into the broader context of demand for these materials, which will be estimated for different periods based on surviving building programmes. Particular attention will be paid to the mid Trajanic period, when extraction of a whole range of materials peaked to feed demand from Trajan's buildings at Rome. This poster, in sum, will touch on questions of quarry organization, imperial administration, and the dialogue between the foremen of imperial building projects and the suppliers of stone at the quarries.

POLYCHROMY IN LARISAEAN QUARRIES AND ITS IMPACT ON ARCHITECTURAL CONCEPTION

Turgut SANER, Gizem MATER, Ertunç DENKTAŞ

Istanbul Technical University, Istanbul, Turkey
(saner@itu.edu.tr; matergizem@gmail.com; ertuncdenktas@yahoo.com)

Keywords: Polychromy, andesite quarries, Archaic

The architectural remains of Larisa (Buruncuk) in western Asia Minor display a skillful stone carving practice based on predominantly andesite (occasionally also basalt), tuff and limestone. A particular scale of colors ranging between bluish-gray and reddish-brown can be observed at local quarries of ancient Larisa. The main quarries in Larisa West provided the entire color set whereas the rock formation in Larisa East – about 1.5 km away from the western settlement – is determined by a (light) reddish-brown version. Basically magnesium and iron minerals (and their concentration) gave their characteristic colors to the natural layers of rocks. During the fieldworks in Larisa (started in 2010), the southeastern and northern quarries have particularly been studied in detail, including research on color and quarrying methods.

One of the major features of Larisaean architecture is the use of masonry blocks showing many different colors presented by the site's quarries. Especially late archaic buildings such as the Megaron and the defense walls of the tyrannical residence bear the vivid combination of andesite blocks. Only at one case (at "Tower I" where bluish-gray polygonal blocks are leveled out with a flat reddish layer), it is possible to assume that the decorative purpose is in the foreground. At other walls with random color combinations, practical and efficient use of quarry blocks must have played the primary role. It should also be mentioned that colorfully painted architectural terracotta plates once decorated the buildings of Larisa, applied on mud brick walls supported by stone wall bases. The use of multi-colored andesite blocks (and others inserted), thus, perfectly matches with this special archaic conception in architecture. When the stonework and the painted terracotta plates are virtually brought together in drawings they perfectly illustrate the taste of polychromy of the archaic Greek art.

TESTIMONIES OF RELICS OF IMPORTED COLORED MARBLE IN THE LAND OF ISRAEL

Dror SEGAL

Museum of Regional and Mediterranean Archaeology, Spring Valley (Beit- Sean Valley), Israel (mus@gan3.co.il)

Keywords: Import, colored marble, Israel Land and Cities in the Roman and Byzantine pearíods

No natural resources of metamorphic marble exist in the Southern Levant region. This is particularly true, for the Roman Era.

Hence, every piece of grayish-white marble, being excavated at archaeological sites, must have been imported: quarried in Asia Minor, Greece and so on. Research, in Hippos-Sussita and Hammat-Gader suggests that most of the grayish-white marble originates from the imperial quarries of Proconesos, but also from Paros, Naxos, Tassos, Aphrodisiacs, Dokimion-Afion and so on.

In these presentations, we deal and focus on the almost rare colored marble: reddish, greenish, yellowish shades, exposed in the excavations in this area. The Colored marble found in few geographic areas and sites:

A number of colored marble slabs were found in Hippos Sussita and in Hammat Gader. Most of them were imported from the quarries at Skyros and Iasos.

Several columns found at the site of Ashkelon excavation, on the Southern part of the Mediterranean Sea shore. These probably originate from the island of Skyros.

Colored marble was excavated from the big site and the significant port of Caesarea by the Mediterranean Sea. Several architectonic artefacts made of colored marble were excavated in the dig of the big site of Beit- She'an-Nyssa- Schytopolis.

Greenish Cipollino marble from the peninsula Evia in Greece, exposed in several other sites, like the main cathedral of Hippos Sussita, Nyssa Schytopolis, and other sites in the land of Israel.

It appears that the Roman rulers and Roman builders in general, tried to reduce costs by using both, local and imported stones. However, for special

constructions and locations, they did not hesitate to import unique types of marble and other stones. In later periods, part of them has been lost in white wash kilns. We are quite sure that more colored marble will be exposed in future excavations.

THE USE OF COLOUR IN ROMAN MARBLE SARCOPHAGI

Eliana SIOTTO

Visual Computing Lab, ISTI – CNR, Pisa, Italy; IBAM – CNR, Catania, Italy
(eliana.siotto@isti.cnr.it)

Keywords: polychromy, Roman marble sarcophagi, colour palette, painting techniques, pictorial effects, paradigms

Roman marble sarcophagi have been systematically studied from a typological, stylistic and iconographic point of view since the late nineteenth century. Several studies also concerned the marble used, the production sites, and the issues related to their use and re-use from Late Antiquity. Conversely, the study of polychromy (painting and gilding) was often given lower consideration. Therefore, nowadays there is only little knowledge about pigments, dyes, and binders used by Roman artists, and about the pictorial style and the techniques used to apply both colour and gilding. A renewal of scientific interest for ancient polychromy, a methodological and multidisciplinary approach to the study of preserved traces of colour on Roman marble sarcophagi could today retrieve valuable information to fully understand this class of artefacts.

Going in this direction, we have identified and catalogued eighty Roman sarcophagi – some even in fragments – with polychrome and gilding evidence in the collections of the Musei Vaticani, the Museo Nazionale Romano, and the Musei Capitolini. They were all investigated by naked eye or a magnifying glass; some of these sarcophagi – preserved at the Musei Vaticani and the Museo Nazionale Romano – were selected as case studies and submitted to more detailed scientific investigations. Their choice was determined either because of some special polychrome features or because of polychrome features common to other sarcophagi.

The technical examination was based on the application of multispectral imaging (Ultraviolet-UV, Infrared-IR, Visible Induced Luminescence-VIL), spectroscopic and elemental analysis (Fourier-transform infrared spectroscopy-FTIR, X-Ray fluorescence-XRF). However, since various materials and structural layers are often applied in marble surfaces, micro-

invasive techniques (Optical Petrographic Microscopy-OPM, Scanning Electron Microscope and Energy Dispersive X-Ray Spectrometer-SEM/EDS, and Raman spectroscopy) were necessary for the scientific analysis of polychrome traces.

Combining archaeological research with the scientific results and the evidences achieved from visual observation, this study aims to improve the knowledge of polychrome Roman sarcophagi by showing the first observations about the colour palette detected and the painting techniques. Specifically, we can see how the colours preserved were more often obtained from a careful mixture of pigments or an overlapping of colours, directly applied to a marble surface or, less frequently, over a whitish ground layer. The Roman painters paid attention to pictorial effects, such as the light and the rendering of minimal details, in order to achieve a realistic effect. We also identified some recurring technical and stylistic elements used, regardless of the iconographic themes and the historical period. Therefore, the ancient polychromy of Roman marble sarcophagi, where still well preserved, appears to be an art of great refinement and technical sophistication on a par with the marble carving.

EMBELLISHING CENTRAL ADRIATIC ITALY IN ROMAN TIMES – THE USE AND TRADE OF MARBLE

Devi TAELMAN,[1] Dimitrij MLEKUŽ[2]

[1]Department of Archaeology, Faculty of Arts and Philosophy, Ghent University, Ghent, Belgium (Devi.Taelman@UGent.be)
[2]Department of Archaeology, Faculty of Arts, University of Ljubljana, Ljubljana, Slovenia (dmlekuz@gmail.com)

Keywords: Marble use, Stone transport, Central Adriatic Italy

Central Adriatic Italy is a region geologically characterised by few stone resources suitable for architectural decoration. Nevertheless, many fragments of high-quality decorative stones (including white and coloured marbles) have been recovered from archaeological excavations and surveys in the region. These stones used for architectural decoration thus had to be imported from more distant sources.

This paper presents a preliminary synthesis of the use and distribution of the different lithotypes used for embellishing the monumental architecture in Central Adriatic Italy. In particular, the results are presented for five Roman towns: *Forum Sempronii, Helvia Ricina*, *Potentia*, *Suasa* and *Trea*.

All sites show a wide range of stone types that were used for their embellishment, including different varieties of the most expensive types of decorative stone used and traded in the Roman period, extracted notably in Greece, Asia Minor, Egypt, Italy and North Africa. Comparison of the relative volume of imported goods for the five sites and the distribution patterns of different types of decorative stones, provides a better understanding of the variables that influenced the mode of distribution of stone architectural decoration.

Particular attention is given to the importance of transport costs in the distribution of stone architectural decoration. It is generally believed that the distribution of bulky and heavy goods – such as ornamental stone – is particularly related to the cost of their transport. Transport constituted a major expense in construction projects in preindustrial times, sometimes even exceeding the costs of the actual raw material and its quarrying. Deviating distribution patterns in relation to transport costs could indicate external intervention (e.g., by the state) in the prevailing market system.

For depicting the predicted costs of transporting different loads and using different technologies (ox carts), an energyscape model is created, offering a basic analytical tool for understanding the costs of movement and transport of stone material, and therefore allowing a deeper understanding of the importance of energy requirements as a variable for structuring the Roman economy. The energyscape model is compared with the decorative stone assemblages of the five Roman towns and the observed distribution patterns of the different lithotypes to determine the impact of transport costs on the trade of decorative stone in Central Adriatic Italy.

PROVENANCE STUDY OF ROMAN SARCOPHAGI FROM NICOPOLIS, EPIRUS, GREECE: THE QUESTION OF LOCAL PRODUCTION VERSUS MARBLE ORIGIN

Dimitris TAMBAKOPOULOS,[1] Yannis MANIATIS,[1]
Theodosia STEFANIDOU-TIVERIOU,[2] Eleni PAPAGIANNI[2]

[1]Laboratory of Archaeometry, Institute of Nanoscience and Nanotechnology, NCSR "Demokritos", Attiki, Greece
(d.tambakopoulos@inn.demokritos.gr; y.maniatis@inn.demokritos.gr)
[2]Department of Archaeology and History, Aristotle University of Thessaloniki, Thessaloniki, Greece (valeria@hist.auth.gr; elpapag@hist.auth.gr)

Keywords: Marble, Provenance, Sarcophagi, Nicopolis

The city of Nicopolis in Epirus, Greece was founded by Octavian, in memory of his victory at Aktion (31 BC) over Marcus Antonius and Cleopatra, and flourished during the Roman period. A large number of marble sarcophagi were discovered in the extensive Roman necropolis of the city. They belong to a later phase of the city, dating from the Hadrian times and onwards to the middle of the 3rd c. AD. The archaeological study, based on typological and stylistic criteria indicates that the majority of them seem to be the product of local workshops, which frequently closely follow the Attic models. However, an important group of sarcophagi seems to be direct imports from Attica, and a few others are works reflecting Asia Minor influences. When compared to the provenance of the marble used for their production, based on qualitative optical observations, this categorization raises certain important questions: 1) a number of the sarcophagi considered local appear to be made of Pentelic marble, and 2) a small number of sarcophagi which could be considered imports from Attica, are made of a marble which cannot be readily identified as Attic.

In order to clarify these questions, 14 representative sarcophagi from the Archaeological Museum of Nicopolis were sampled and subjected to full scientific provenance analysis. This involved a combination of a) in-situ examination of the whole object using optical techniques for measuring transparency, grain size distribution, inclusions, veins and other features, b) Stable Isotope Analysis, and c) Electron Paramagnetic Resonance Spectroscopy.

The preliminary results seem to reveal that the majority of locally made sarcophagi not only imitate Attic works, but they are also made in Pentelic marble to be even more appealing to the customers. However, the quality and features of this Pentelic marble is challenging and probably points to a specific location on the mountain. There are also cases of sarcophagi following other models (e.g. Macedonian or Asia Minor) whose marble needs to be identified in order to clarify their exact origin and association.
This combined work is expected to reveal the patterns of sarcophagi production and trade at Nicopolis and clarify the questions of what has been moved in each time, i.e. the raw material, the finished product, the artists or the "fashion". Also questions about real local production, versus imports from elsewhere, but following also the Attic models, are expected to be clarified.

A CORINTHIAN CAPITAL OF 'PIETRA DI AURISENA' ON PROCONNESOS. A PROTOTYPE FOR QUARRY PRODUCTION OR A STRAY FIND?

Natalia TOMA

Institute for Classical Archaeology, University of Kiel, Kiel, Germany
(ntoma@klassarch.uni-kiel.de)

Keywords: 'pietra di Aurisena', prototype, Proconnesos

At the beginning of the 1990s L. Lazzarini and P. Pensabene identified a Corinthian capital on Proconnesus that was not carved of the local marble, but of 'pietra di Aurisena', a limestone from the area of Trieste extensively used in the Imperial architecture of Northern Italy and the Adriatic region. The style of the acanthus leaf evidenced its origin from the Western part of the Roman Empire. The origin of the capital and of its material, as well as the fact that some decoration elements looked unfinished contributed substantially to considering it as a prototype for capital production on the Island. The preservation state of the capital and the traces on its abacus surface show that it did not originate from a destroyed building, but was rather dismantled. The closest parallel for the capital laying on Proconnesos is a capital that belonged to a Julio-Claudian monumental Gate of the ancient Trieste, now integrated in the medieval architecture of the Cathedral of San Giusto.

The aim of the poster is to present photographic evidence of this capital and to deliver arguments for discussing the possible interpretations of this capital. I favour the opinion that this capital arrived on the Island in Late Antiquity, most probably as a ship's ballast.

APHRODISIAS AND THE REGIONAL MARBLE TRADE. THE CASE OF THE SCAENAE FRONS OF THE THEATRE AT NYSA

Natalia TOMA

Institute for Classical Archaeology, University of Kiel, Kiel, Germany
(ntoma@klassarch.uni-kiel.de)

Keywords: Nysa ad Maeandrum, Aphrodisian marble, regional distribution

The Carian city of Aphrodisias is famous for its local marble sculpture tradition and is surrounded by marble quarries of both 'local' as well as interregional significance (e.g. Göktepe). The studies of D. Attanasio, M. Bruno und B. Yavuz showed that the quarries of Göktepe were the main marble supplier for Aphrodisian sculptors whose statuary was exported to Rome and North Africa. L. Long recently studied the local marble quarries surrounding the city and argued that local resources were barely sufficient to supply the demand for public architecture in the city itself. Therefore, the export of Aphrodisian marble for building purposes seems rather improbable.

This paper is focused on the scaenae frons of the theatre at Nysa ad Maeandrum (Caria) and presents new results of provenance determination of the marble used for this column architecture. They indicate that the reconstruction of the scaenae in the late 2nd century AD was done by using marble from Aphrodisias for the entablature and from Denizli for the columns shafts.

After a brief presentation of the theatre architecture – that M. Kadioglu reconstructed in a monograph published in 2006 – the paper concentrates on the building phases of the monument and on the material used for its construction. The interesting fact about the entablature of the 1st storey is, that not all architectural items were carved of single blocks and that some of them were hollowed out. This indicated that the supplies of Aphrodisian marble used for the theatre of Nysa were scarce, which fits into the observations made by L. Long regarding the Aphrodisian quarries. They show at the same time that Aphrodisian marble – though a limited resource – was exported for building purposes on a regional level in the 2nd century AD.

STANDARDISED PRODUCTION OF MONOLITHIC SHAFTS. NEW EVIDENCE CONCERNING THE IMPERIAL BUILDING INDUSTRY

Natalia TOMA

Institute for Classical Archaeology, University of Kiel, Kiel, Germany
(ntoma@klassarch.uni-kiel.de)

Keywords: standardised production, monolithic shafts, building industry

"Standardisation, accompanied by a considerable measure of prefabrication" is according to J. B. Ward-Perkins a central feature of the Imperial marble trade. Although the marble trade model of J. B. Ward-Perkins was published in a very concise manner and without sufficient argumentation, it remained since the 1980s very influential in archaeology. In his 2013 published study on the Roman stone trade, B. Russell expressed the opinion that the evidence of prefabricated monolithic shafts in the quarries is not sufficient to prove a quarry-based serial production of architectural items having standardised sizes.

This paper addresses this highly actual topic of standardised production of architectural items in the Imperial building industry and presents the results of a systematic research including 22 quarries, 58 shipwrecks, the marble yards of Rome and the architecture of four regions with and without their own marble supplies (Tripolitania, Baetica, Southionia and Moesia); these results attest the extended use of monolithic shafts with standard length in the Imperial architecture.

The paper includes two parts: first, a presentation of relevant evidence of sets of prefabricated monolithic shafts abandoned in quarries (Karystos, Troas and Mons Claudianus) and found in shipwrecks (Giardini Naxos, Punta Scifo A, Torre Chianca). They clearly show that one of the main features of the quarry production was the serial production of monolithic shafts and suggest a certain degree of standardisation of the shaft length.

The final part of my talk focuses on examples of public architecture from different regions – Leptis Magna (the Severan complex), Ephesos (the bath-gymnasia) and Italica (the Trajaneum) – and offers the arguments for broad use of monolithic column shafts with standard lengths of multiples

of 4 and 5 Roman feet. The conclusion will show that such standardised shafts were part of similar architectural solutions, a fact that indicates the development of a certain mass-architecture in the Imperial time.

THE USE OF "OTHER STONES IN ANTIQUITY" IN CROATIA: LONG DISTANCE ACQUISITION OF OBSIDIAN IN THE NEOLITHIC PERIOD

Robert H. TYKOT,[1] Luke R. ADAMS,[2] Jacqueline BALEN,[3] Bryon BASS,[4] Philippe DELLA CASA,[5] Stašo FORENBAHER,[6] Timothy KAISER,[7] Darko KOMŠO,[8] Emil PODRUG[9]

[1]Department of Anthropology, University of South Florida, Tampa, Florida, United States (rtykot@usf.edu)
[2]Archaeology, University of Southampton, Southampton, United Kingdom (adamslukeuk@hotmail.com)
[3]Archaeological Museum in Zagreb, Zagreb, Croatia (jbalen@amz.hr)
[4]University of Zurich, Zurich, Switzerland (bryon.bass@gmail.com)
[5]Prehistoric Archaeology, University of Zurich, Zurich, Switzerland (phildc@access.uzh.ch)
[6]Institute for Anthropological Research, Zagreb, Croatia (staso.forenbaher@inantro.hr)
[7]Anthropology, Lakehead University, Orillia, Canada (tkaiser@lakeheadu.ca)
[8]Archaeological Museum of Istria, Pula, Croatia (darko.komso@pu.htnet.hr)
[9]Šibenik City Museum, Šibenik, Croatia (emil.podrug@muzej-sibenik.hr)

Keywords: obsidian, Croatia, non-destructive pXRF

Obsidian stone tools were used in Croatia as early as the Early Neolithic period (ca. 6000 BC), with the closest geological sources in northeastern Hungary, Slovakia, and some of the Tyrrhenian islands of Italy and Aegean islands of Greece. While some obsidian artifacts had been found long ago, research on prehistoric sites has increased tremendously in the past two decades since Croatia became independent. Along the Adriatic coast (Dalmatia), obsidian has been found in significant quantities at the excavated sites of Danilo, Pokrovnik and Krivače in southeastern Croatia, at sites in Istria including Kargadur, and on the islands of Sušac and Palagruža. Obsidian has also been found in large quantities at sites in northern Croatia such as Samatovci. Overall, this demonstrates significant and regular exchange or contact between Croatia and other parts of Europe, by land and/or by sea.

Starting in 2001, chemical analysis has been conducted on more than 250 obsidian artifacts from Croatia, in addition to many geological samples from the Italian island sources of Lipari, Palmarola, Pantelleria and Sardinia, from Carpathian Basin sources in the Tokaj mountains of Hungary and Lower Zemplín of Slovakia, and the Greek island of Melos. Trace

element analyses in particular have been shown to distinguish not only between these sources, but also subsources for each. Analyses were conducted using a portable, non-destructive X-ray fluorescence spectrometer (pXRF), which provides quantitative trace element data.

The results obtained show that obsidian artifacts in Croatia came mostly from two main sources, Lipari for sites along the Adriatic, and Lower Zemplín (Slovakia) for sites in northern Croatia. The sites tested in northern Croatia had obsidian only from Carpathian sources, while obsidian from the Carpathians made its way to Adriatic sites in Istria as well as to Danilo and Pokrovnik in southeastern Croatia, but just in small percentages compared to the Lipari obsidian. Just a few pieces from Palmarola were found on Sušac, and from Melos on Palagruža. Significantly, all of the Lipari artifacts come from the Gabellotto subsource, and all but one of the Carpathian artifacts came from Viničky.

These results are combined with other studies for the European/Mediterranean Neolithic through Bronze Age to evaluate the patterns observed, and integrate the data for obsidian with movement of other materials such as ceramics. This study exemplifies the importance of analyzing a significant number of artifacts in order to make strong interpretations about ancient cultures and their socioeconomic systems.

ANALYSIS OF CLASSICAL MARBLE SCULPTURES IN THE MICHAEL C. CARLOS MUSEUM, EMORY UNIVERSITY, ATLANTA

Robert H. TYKOT,[1] John J. HERRMANN,[2] Renée STEIN,[3] Susan BLEVINS,[4] Jasper GAUNT,[3] Anne R. SKINNER[5]

[1]Department of Anthropology, University of South Florida, Tampa, Florida, United States (rtykot@usf.edu)
[2]Museum of Fine Arts, Boston, United States (jherrmannjr@gmail.com)
[3]Michael C. Carlos Museum, Emory University, Atlanta, Georgia, United States (rastein@emory.edu; jgaunt@emory.edu)
[4]University of Georgia at Athens, Athens, Georgia, United States (sludi@emory.edu)
[5]Chemistry Department, Williams College, Williamstown, Massachusetts, United States (askinner@williams.edu)

Keywords: Carlos Museum marble, advances in provenance techniques, Denizli marble

Approximately fifty classical marble objects have come into the collections of the Michael C. Carlos Museum at Emory University. All have been visually examined to gauge relative grain size and translucency. The objects have also been analyzed using several complementary techniques to determine the quarry sources for the marble. Stable isotope ratios for carbon and oxygen were analyzed from samples drilled from each object and compared to databases for Mediterranean marble quarries. X-ray fluorescence spectroscopy was used to determine the presence of magnesium, manganese and strontium. Electron paramagnetic resonance analysis was conducted on selected samples to further narrow the quarry attributions.

This paper presents five case studies that were of special interest, either for art-historical reasons or for the use of marble from unexpected sources. The marbles discussed include an under life-size Hellenistic statue of a draped female (Terpsichore? Aphrodite?), whose head is carved from marble assigned to the Paros 1 quarries, while the body is Pentelic. An archaistic relief of a woman carrying a jug for libations is carved from Denizli marble, perhaps the first such identification for archaistic sculpture. A Roman statue representing Leda and the Swan is carved from Paros 2 marble. A fine Roman statuette representing Apollo of the Anzio type is carved from Carrara marble. An unusual Roman third-century relief of a ploughman uses marble from Göktepe.

Overall, this research illustrates the necessity of a multi-method approach to marble sourcing, while demonstrating that it can be done with minimal effects on important museum objects. The identification of the source of the marble used for the significant assemblage of objects on display in this museum provides important information for both museum visitors and those studying the acquisition of marble and its use in antiquity.

ROMAN MONOLITHIC FOUNTAINS AND THASIAN MARBLE

Annewies VAN DEN HOEK,[1] Donato ATTANASIO,[2] John J. HERRMANN[3]

[1]Harvard Divinity School, Cambridge, Massachusetts, United States (ahoek@hds.harvard.edu)
[2]Istituto di Struttura della Materia, Consiglio Nazionale delle Ricerche (ISM-CNR), Rome, Italy (donato.attanasio@ism.cnr.it)
[3]Museum of Fine Arts, Boston, Dedham, Massachusetts, United States (jherrmannjr@gmail.com)

Keywords: Paramagnetic resonance spectography (EPR), macroscopic identification, Cape Vathy Thasos, Vatican, Pula, preferred material

A small group of marble fountains are solid blocks that have staircases for cascades on all sides and are topped with a shallow pool with a central water inlet or jet. The inlet often has the form of a cup or jar. These small fountains apparently took their origin from masonry fountains jacketed with marble like one in Pompeii, and they seem to have been produced between 80 and 140 CE. Like the Pompeian fountain, the most archaic type of monolithic fountain was a block without decoration on the sides other than the stairs. The fountains seem to have undergone an evolution toward more complex and richly decorated forms. Seashells, Gorgon masks, sleeping nymphs or satyrs could be carved at the top of each staircase. The corners between the stairs came to be decorated with ram's heads, heads of Neptune, standing figures of satyrs, children pouring from rhyta, and reliefs with stories of Ulysses. In a final phase of enrichment, the fountains become circular and have an uneven number of stairways, either five or seven. Examples are known from Lambaesis and Cherchel in Algeria, Pula in Croatia, and Tarragona in Spain, but most are in the Vatican.
Analysis with paramagnetic resonance spectography (EPR) demonstrates that four of the five fountains in the Vatican are coarse-grained dolomitic marble that must come from Thasos. The example in Pula is obviously Thasian as well. Overall 5 of the 9 pieces are Thasian marble, an abnormally high percentage for this material, which is uncommon outside the north Aegean. The material may have been popular for fountains because of its

physical characteristics; dolomite is notably harder than calcite, and it may have been thought to be more resistant to running water. While it seems clear that Rome was the center from which the fountains radiated, it is also possible that a sculptor from Thasos directed the workshop there. The sleeping figures on the fountains have similarities to statuettes of sleeping figures of Thasian marble produced in the north Aegean.

BRECCIA CORALLINA AND PAUL THE SILENTIARY

Annewies VAN DEN HOEK,[1] John J. HERRMANN[2]

[1]Harvard Divinity School, Cambridge, Massachusetts, United States
(ahoek@hds.harvard.edu)
[3]Museum of Fine Arts, Boston, Dedham, Massachusetts, United States
(jherrmannjr@gmail.com)

Keywords: Description of Hagia Sophia, Constantinople; Lydian promontory, Vezirhan, Karaburun Peninsula, Çakmakli

Experienced observers have long recognized that *breccia corallina* was quarried in Turkey and exported intensively to Italy and sporadically to other places around the Mediterranean. The stone has creamy white clasts in a coral-red cement.

Lorenzo Lazzarini has identified ancient quarries of the stone near Vezirhan, in the area of ancient Bithynia in NE Turkey. Lazzarini characterized the stone petrographically and isotopically and has also identified it with the *marmor sagarium*, named in ancient sources.

At the ASMOSIA meeting in Tarragona, Matthias Bruno, Donato Attanasio, and Bahadir Yavuz, announced the discovery of additional quarries of breccia corallina, this time near the Aegean coast of Turkey. Some of the quarries are on the Karaburun Peninsula, and another is inland from them at Çakmakli near the city of Manisa.

The website of the Oxford Roman Economy Project suggests that these newly-discovered quarries were only of regional significance, but this may understate their importance. The western Anatolian breccia corallina quarries have apparently left a record in the literary sources of antiquity. Bente Kiilerich has recently identified breccia corallina among the marbles praised by Paul the Silentiary in his poetic description of Hagia Sophia in Constantinople, written at the time of the building of the church in the sixth century. "You may see .... how much the Lydian promontory (produced), winding around the color of pale yellow mixed with red." The pale yellow and red suits breccia corallina fairly well, and Hagia Sophia, in fact, has some breccia corallina in its wall revetments. Kiilerich connected this breccia corallina with the stone quarried at Vezirhan. The Silentiary, however, explicitly places the stone in Lydia not Bithynia, and the new quar-

ries fall in the ancient province of Lydia. Moreover, a term the Silentiary employs characterizes the location even further. The word for promontory, ὁ ἀγκών, can mean either the bend of an arm or headlands that form a bay. The metaphor of a bent arm corresponds well with the shape of the Karaburun Peninsula.

The published photographs of the stone from the various quarries of breccia corallina suggest subtle macroscopic difference between them, but it is highly desirable that laboratory analyses be conducted to put these distinctions on a sounder basis.

RECORDING AND MAPPING ANCIENT QUARRIES IN THESSALY, CENTRAL GREECE

Marianthi VAVALIOU,[1] Markos VAXEVANOPOULOS,[2]
Vasilis MELFOS,[2] Georgios ECONOMOU[3]

[1]School of Architecture, Faculty of Engineering, Aristotle University of Thessaloniki, Thessaloniki, Greece (ithnairam@yahoo.gr)
[2]Department of Mineralogy - Petrology - Economic Geology, Faculty of Geology, School of Sciences, Aristotle University of Thessaloniki, Thessaloniki, Greece (vaxevanopoulos@gmail.com; melfosv@geo.auth.gr)
[3]Institute of Geology and Mineral exploration, Athens, Greece (georgeoik7@gmail.com)

Keywords: Quarry, marble, limestone, mapping, recording, Thessaly

Several quarries have been studied in the Greek territory the last two centuries under the prism of archaeological, geological and engineering sciences. In most of these studies, the geographical data are sparse or difficult to use. A concentrated and collective study of the ancient Greek quarries with geographical, archaeological and topographical data could be a very useful tool for those who are studying the ancient technology. Moreover, some of these decorative stone quarrying centers are in danger due to intense modern quarrying and so the identification and documentation of ancient extraction sites is of vital importance to secure them for the future. In Thessaly, civilization dates back to the Neolithic period and includes significant cultures through the times, which played a significant role in the development of this area. The raw materials used in various building constructions were obtained from numerous quarries which extended in the whole region. A method of recording and mapping these ancient quarries is proposed in this study. The record concerns the geographical location of the quarries and the related data such as covering area and altitude. All the quarries have already been mapped and all the archaeological and geological information is documented. The stones extracted from these quarries are mainly white to gray marbles, limestones, sandstones, basalts and ophicalcites.

Through this study, we gather all the available and new research results for a better understanding of the geological setting and the physical and mechanical properties of the rocks. Additionally, combining these data with

archaeological finds we can come to useful conclusions about the human interaction with the raw material resources, such as the use of the rocks, the application of the technology in antiquity and the possible distribution of these rocks. This approach is very valuable for identifying indirectly the reasons for their selection and use. This useful database could be used for future provenance studies of various objects and building stones found in archaeological sites within or outside Thessaly.

QUARRIES OF AN ANCIENT TOWN CLOSE TO THE MODERN CITY OF VOLOS, THESSALY, CENTRAL GREECE

Markos VAXEVANOPOULOS,[1] Marianthi VAVALIOU,[2]
Vasilis MELFOS,[1] Georgios ECONOMOU[3]

[1]Department of Mineralogy - Petrology - Economic Geology,
Faculty of Geology, School of Sciences, Aristotle University of Thessaloniki, Thessaloniki,
Greece (vaxevanopoulos@gmail.com; melfosv@geo.auth.gr)
[2]School of Architecture, Faculty of Engineering, Aristotle University of Thessaloniki,
Thessaloniki, Greece (ithnairam@yahoo.gr)
[3]Institute of Geology and Mineral exploration, Athens, Greece (georgeoik7@gmail.com)

Keywords: Quarry, marble, provenance, Orminion, Thessaly, Volos

An ancient fortified settlement near the modern city of Volos, in Thessaly, Central Greece, is characterized by the presence of a number of marble quarries. This ancient town is possibly "Orminion" flourishing during the fourth century BC. It is located on the Goritsa hill, part of Mount Pelion, NE of Volos city. Many small or larger quarries were recorded in and around the settlement. The extracted rock is a coarse to fine grained grey marble, which sometimes is brecciated due to the tectonic brittle deformation.

A detailed mapping of these quarries has been carried out in order to understand the geological setting and the applied quarrying methods. At the ancient quarries rock wedging is the main quarrying technique whereas in many sites narrow trenches are used for isolating the marble blocks. The open quarries and over 25 quarrying locations were geologically mapped during this study.

The archaeological research demonstrated that the material was mainly used for the construction of the fortress wall of the settlement and its towers. An intense use of these marbles is also recognized at several buildings inside the ancient town, at the roads, at the city's aqueduct and the cisterns. This material was also used at the constructions of an early Christian temple on the hill of "Kastro-Palaea" in the centre of the city of Volos.

NOTAE LAPICIDINARUM: DOCUMENTATION AND ANALYSIS OF QUARRY MARKS FROM PROVINCIAL FORUM OF *TARRACO*

Maria Serena VINCI

Institut Català d'Arqueologia Clàssica (ICAC), Tarragona, Spain (svinci@icac.cat)

Keywords: quarry marks, quarrying organization, Provincial Forum of Tarraco

The purpose of the proposed study refers to the documentation and analysis of the quarry marks visible on the limestone blocks that build the monumental construction, made in *opus quadratum*, of the Provincial Forum of *Tarraco*.

The quarries exploited for the construction of the imperial monument are local quarries, in particular the provenance of the majority of the material is from the quarry Mèdol.

The quarry marks analyzed, are visible just in a specific area of the intermediate terrace that forms the architectural complex of the ancient capital of *Hispania Citerioris*. The sector is referred to as Pretori Tower, one of the main means of access between intermediate terrace, the site of the annual meeting of the *conciulium provinciae Hispaniae Citerioris*, and the circus.

The *notae lapicidinarum* of the Provincial Forum of *Tarraco* are mainly letters and numerals, beyond one symbol. Some of the quarry marks shown in this study are still unpublished. The others were already known since 1962, when they were discovered during the only archaeological excavation carried out in the Pretori Tower. However, the discovery is only mentioned, but the significance of the marks on the blocks has never gone in depth or has their connection with the operations of the *cantiere di costruzione* ever been studied.

The signs, letters or inscriptions marked on the architectonical elements are largely attested for the Roman period, but their interpretation is still uncertain above all for symbols and monograms.

For all these reasons, the analysis of the quarry marks of the Provincial Forum of *Tarraco* contributes to collect new information about a complex subject. Besides, it highlights some of the aspects of the organization of the activities connected to the extraction and with the operations of construction of the one of most important monuments in the Roman provinces.

COLOURED MARBLE SLABS WITH GOLD LEAF DECORATIONS FROM THE GORGA COLLECTION

Sabrina VIOLANTE

Soprintendenza Speciale per i Beni Archeologici di Roma, Rome, Italy
(sabrina.violante@beniculturali.it)

Keywords: Gorga Collection, Gilding, Wall veneer

Among the materials in the collection of the famous Italian tenor Evan Gorga (1865-1957), a small number of slabs in coloured marbles with gold leaf decorations are of considerable interest. These are fragmentary pieces of limited size in *basanite*, *rosso antico*, *rosso brecciato* and *serpentino*; the ornamental motifs in gold leaf are of geometrical or plant type, or, in some cases, of uncertain interpretation. These fragments, of unknown provenance and today at the Museo Nazionale Romano, must have belonged to the wall veneer of a luxurious room commissioned by an important personage, probably to be sought in imperial circles. It is likely that the collector obtained these materials in Rome itself, given Gorga's intense activities in the capital and above all the high quality of the pieces. The presence of *rosso brecciato* from Iasos, whose use is first documented in Rome in the 3rd century AD, represents an important *terminus post quem* for the date of the materials and suggests a chronology in the late antique period, in line with the imperfect working of the edges of the slabs and the presence of what are probably reused marbles.

At the current state of knowledge, these pieces, which have exceptionally survived the passage of time, have no exact parallels and are unique in the decorative repertoire of the Roman period. Here we will present the results of the quantitative ED-XRF analyses carried out on some specimens of gold leaf and the results of studies – still under way in collaboration with the CNR in Florence – on the composition of the adhesive used to apply the gilding.

ATHENS, NATIONAL ARCHAEOLOGICAL MUSEUM: ANALYSIS OF SCULPTURES FROM THE ROMAN COLLECTION

Massimo VITTI,[1] Matthias BRUNO,[2] Donato ATTANASIO[3]

[1]Sovrintendenza Capitolina Beni Culturali, Rome, Italy (maxvitti@gmail.com)
[2]Via dei Vascellari 34, Rome, Italy (matthiasbruno@libero.it)
[3]Istituto di Struttura della Materia, Consiglio Nazionale delle Ricerche (ISM-CNR), Rome, Italy (donato.attanasio@ism.cnr.it)

Keywords: Athens, sculpture, archaeometry, marble provenance

The National Archaeological Museum of Athens has the biggest collection of ancient sculpture in Greece with statues not only from Athens but from all over the country. Thanks to a bilateral program between Italy and Greece sponsored by the Italian Foreign Ministry, it was possible to sample about 76 items in white marble on display in the Museum or in the storerooms: 26 portrait heads, 19 statues, 14 trapezophori, 5 sarcophagi and 12 architectural elements. The obtained samples were submitted to archaeometric analyses (stable isotopes, EPR) in order to investigate their marble provenance. As to be expected in a marble rich country, about 80% of the considered items were produced in Greek marbles, mainly the local one from Mount Pentelikon (statues inv. 243, 246, 3567, sarcophagi inv. 1186, 1187, head inv. 3004), followed be the high prized statuary marble from the islands of Paros (heads inv. 348, 529, 1762) and the coarse white one from Cape Vathy on Thasos (heads inv. 357, 4536). Marbles from Asia Minor represent the remaining 20 %. Proconnesian marble was used for two male heads (inv. 372, 4011), some trapezophori (inv. 2638, 2809, 5714) and a sarcophagus (inv. 15380), the white *docimium* marble quality was used for two portrait heads (inv. 419, 356399), while the white statuary aphrodisian Göktepe marble is attested in two male portrait heads of the end of the II century AD depicting very probably the emperors Commodus and Septimius Severus (inv. 488, 991). The results of the marble provenance investigation of the statues, sculptures and other items of Roman imperial period in Greece show that foreign marbles were imported in spite of the large quantity of local high quality sources. Especially from the mid 2nd century AD, Asiatic marbles were imported, connected likely to special ateliers and sculptors, travelling probably together with their homeland marbles, as well attested by the white docimium and Göktepe male heads.

DOKIMEION AD 2014
THE FIRST SEASON OF THE PROJECT "MARMORA ASIATICA TOWARDS ARCHAEOPETROLOGY IN POLAND"

Dagmara WIELGOSZ,[1] Fabrizio ANTONELLI,[2]
Marcin BOJANOWSKI,[3] Stefano CANCELLIERE,[2] Demir ERKANOL,[4]
Marcin GŁADKI,[5] Agnieszka JARMEK,[5] Lorenzo LAZZARINI,[2]
Michał RUSZKOWSKI,[6] Nilgün ŞENTÜRK[7]

[1]Institute of Archaeology, University of Warsaw, Warsaw, Poland
(dagmara.wielgosz@uw.edu.pl)
[2]Laboratorio di Analisi dei Materiali Antichi,Università IUAV di Venezia, Venice, Italy
(fabria@iuav.it; stefanoc@iuav.it; lorenzo@iuav.it)
[3]Institute of Geological Sciences, Polish Academy of Sciences, Warsaw, Poland
(mbojan@twarda.pan.pl)
[4]MTA General Directorate of Mineral Research and Exploration, Üniversiteler Mah.
Dumlupınar Bulvarı, Ankara, Turkey (demirerkanol@yahoo.com)
[5]PAST Research and Analysis of Heritage, Warsaw, Poland-Norway
(marcin@past.com.pl; agajarem@gmail.com)
[6]Faculty of Geology, University of Warsaw, Warsaw, Poland
(ruszkowskimichal@wp.pl)
[7]Ministry of Culture and Tourism of the Republic of Turkey, Kültür Varlıkları ve Müzeler
Genel Müdürlüğü, Ankara, Turkey (nilgunsinan@hotmail.com)

Keywords: Asia Minor, Dokimeion, quarries, marble

The Institute of Archaeology of the University of Warsaw recently launched an interdisciplinary project "Marmora Asiatica towards archaeopetrology in Poland", financed by the National Centre of Science of the Republic of Poland. One of the objectives of the project is to develop an extensive database of petrographic and geochemical properties of white and grey marbles from quarries of Asia Minor. This database will be a GIS-based internet application accessible to all scholars.

In 2014, a joint archaeo-geological Polish-Turkish mission carried out research in the quarries of Dokimeion, well known to the scientific community since the 19th century. In the 1960s, Josef Röder conducted the most accurate survey of the quarries to date. The German scholar divided the Dokimeion quarries into two main groups: so-called Latin and Greek. Of the two, the "Latin" quarries, and more specifically Baçakale, are the

most known and studied quarries from both archaeological and archaeometrical point of view. During the October 2014 survey, our mission discovered and documented as many as ten marble quarries in addition to those classified by J. Röder. However, a more detailed study of the interrelationship of these sites is needed. The samples collected in the quarries have been subjected to a series of analytical analysis including the standard petrographic and geochemical investigations (carbon and oxygen stable isotopes).

IMPERIAL PORPHYRY IN ROMAN BRITAIN

David F. WILLIAMS

Department of Archaeology, University of Southampton, Avenue Campus, Southampton, Hampshire, United Kingdom (dfw@soton.ac.uk)

Keywords: Porphyry, Mons Porphyrites, opus sectile, wall veneer

Imperial Porphyry, one of the hardest types of stone known, was greatly admired during the Roman and Byzantine periods because the deep purple of the stone was closely associated with the chosen colour of the Emperor himself. The outcrops of this distinctive looking purple volcanic rock, spotted with small white and pink inclusions, are extremely restricted, and are only found in a small area of the Red Sea Mountain range of the eastern Egyptian desert, at Mons Porphyrites. The quarries for this stone, which operated from the Tiberian period until the early fifth century AD, were kept under close Imperial control, with the vast majority of the items produced; sculpture, columns, baths, basins and sarcophagi, only intended for Imperial use or patronage. The numbers of imported exotic coloured marbles found in Roman Britain is not great compared to other provinces.
Moreover, as the vast majority of these finds are restricted to small individual pieces, many of which show signs of being cut to shape, it suggests that they were essentially employed for decorative purposes as *opus sectile* or wall veneer, used as a luxury item for selected buildings of Roman Britain. Amongst these imported coloured marbles are a small number of pieces of Imperial Porphyry, similarily used as *opus sectile* or wall veneer, and associated with a restricted number of sites. This poster records the frequency of the finds, their distribution and likely date-range, as well as suggesting individual quarry areas for some of the pieces using magnetic susceptibility measurements.

GEOARCHAEOLOGICAL STUDY OF THE GREEN SCHIST STONE OF JEBEL EL HAIRECH (NORTH-WEST OF TUNISIA)

Ameur YOUNES,[1] Mohamed GAIED,[2] Wissem GALLALA[3]

[1]Faculté des Sciences Humaines et Sociales Tunis, Tunis, Tunisia (ameuryounes@yahoo.fr)
[2]Institut des Beaux arts Sousse, Sousse, Tunisia (gaiedmoh_gaied@yahoo.fr)
[3]Faculté des Sciences Gabès, Gabès, Tunisia (gallala_wissem@yahoo.fr)

Keywords: Jebel el Hairech, Simitthus, green schist, analyses, quarry, monuments

The green schist is a metamorphic rock formed under the transformation of Permo-Triassic clays from Jebel el Hairech. The Chemtou green schist marble stone was not only used for building and decorating ancient monuments, but also for graving inscriptions and carving statues in the towns of *Simitthus* (Chemtou) and *Thunusuda*(?) (Borj Hellal). From the archaeological and geological point of view, this marble stone has been scarcely studied until now.

During the survey of a part of the Jebel el Hairech area, an ancient open air quarry has been discovered. Samples taken both from this quarry and from the blocks and columns *in situ* in the sites of *Simitthus* and *Thunusuda*(?) have been analysed. The results reveal that blocks and columns have been extracted very likely from this quarry.

This present communication aims at studying first the geotechnical and mineralogical analyses of this marble stone from the quarry and the two sites, and then its different uses in the construction of the ancient towns of *Simitthus* and *Thunusuda*(?).

THE EUGANEAN TRACHYTE, A STONE SOURCE OF *REGIO X* AND ITS USE IN NORTHERN ITALY

Arturo ZARA

Dipartimento dei Beni Culturali, Università degli Studi di Padova, Padua, Italy
(arturo_zara@alice.it)

Keywords: Euganean trachyte, provenance, Roman age

For many years, the University of Padova has been developing a multidisciplinary research project concerning the study of stone materials quarried during Roman age in *Regio X* (*Venetia et Histria*). In recent times, specific attention has been given to the Euganean trachyte, a volcanic rock extracted from the Euganean Hills (Venetian Volcanic Province). The distinctive mechanical properties and especially the remarkable resistance to both abrasion and surface alteration meant that since protohistoric ages and even more in Roman times trachyte had a geographical spread throughout *Regio X*, as well as in *Regio VIII* (*Aemilia*), westwards to Milano/*Mediolanum*, *Regio XI* (*Transpadana*) and to the south at least as far as Urbisaglia/*Urbs Salvia*, *Regio V* (*Picenum*). Frequently employed as a building material in roads (flagstones) and bridges, Euganean trachyte was typically used for the production of millstones, querns and mortars. The great importance of this stone has led us to the creation of a database of structures and infrastructures in which the trachyte was exploited as building material, as well as artifacts carved in this stone. In pursuance of a multidisciplinary approach, it has also been necessary to expand the sampling already made in Emilia Romagna by the team of S. Capedri (University of Modena and Reggio Emilia). Hence we have sampled the most important Roman roads preserved in the Veneto region: the results of archaeometric analyses allow completing the knowledge of active quarries during Roman age in the Euganean Hills and, according to the study of archaeological evidences, of the use of trachyte in Northern Italy, it will lead to an attempt of reconstruction of production systems, organization of quarries, transport routes and economic trends that revolved around Euganean trachyte in Roman times.

DECORATION OF LIMESTONE STELAE FROM THE ROMAN COLONY OF PARENTIUM AND ITS TERRITORY

Valentina ZOVIĆ

Postgraduate study *Archaeology* of the *Eastern Adriatic,* University of Zadar, Zadar, Croatia
(valentinazovic3@gmail.com)

Keywords: stelae, decoration, Parentium

Stelae represent the artistically simplest funerary monument which Romans started using under the influence of Greek sepulchral art. They arrived in Roman Histria during the 1st century BC together with Italic colonists and then gradually developed from simplest and unadorned ones to those very rich in decoration, for instance with architectural elements such as acroteria and pilasters. This type of sepulchral monument was very popular in Histria among different social categories such as colonists who arrived from Italy, autochthons, soldiers and others. A number of stelae, all made of limestone, were found on the territory of the Roman colony of Parentium and its ager during years of excavations. Most of them are preserved in the lapidarium of the *Heritage Museum of Poreč* (Zavičajni muzej Poreštine/ Museo del territorio parentino). Few of them are kept in some other nearby institutions or built somewhere as spolia, and some are lost but still known by photo or drawing. The majority of these monuments are completely or almost completely preserved with all their decoration, and the rest are partly damaged or fragmentary, but nevertheless important. These parts or fragments usually contain significant remains of decoration as aedicula, pilasters, rossete, shells and others, so it is important to include them in the discussion focusing on the quality and complexity of decoration as well. The aim of this paper is to examine these sepulchral monuments and their fragments in order to present and determine what kind of decoration the inhabitants of the territory of Parentium preferred, and how their elements and techniques developed through time.

PROVENANCE ANALYSES OF MARBLE USED IN THE ANCIENT SITE OF TROESMIS (TURCOAIA, TULCEA COUNTY, RO) AND ITS TERRITORIUM (FIRST TO FOURTH CENTURY A.D.)

Judit ZÖLDFÖLDI,[1] Cristina ALEXANDRESCU,[2] Heinrich TAUBALD[3]

[1]Institute of Materials Science, University of Stuttgart, Stuttgart, Germany (judit.zoeldfoeldi@mpa.uni-stuttgart.de)
[2]Institutul de Arheologie Vasile Pârvan, Bucharest, Romania (cgetalexandrescu@gmail.com)
[3]Chair of Isotope Geochemistry, University of Tübingen, Tübingen, Germany (taubald@uni-tuebingen.de)

Keywords: Marble; limestone; granite; Troesmis; legio V Macedonica; municipium

More than 100 marble objects have been included in the material analyses of the Romanian ArheoMedia-project (www.arheomedia.ro). For the northern area of the Roman province Moesia inferior it was evident that the provincials were very much aware of the local resources of stone and their suitable use, being at the same time able to import marble for particular purposes.

The present paper will introduce the case of ancient *Troesmis* (Turcoaia, Tulcea County) on the Danube, legionary fortress of *legio V Macedonica* and later Roman *municipium*, surrounded by a constellation of rural settlements of different level of wealth. Twenty-four marble items have been investigated, representing votive monuments (reliefs and sculpture), funerary statues and, for the first time, elements of the decoration of the walls.

Within the ArheoMedia-project and the *Troesmis*-archaeological project of the Archaeological Institute in Bucharest further sculptural monuments (funerary, honorary and large-scale cultic reliefs) have been investigated. Those have been made of local limestone from the quarries in the middle of the province (so-called Babadag area). Imported crafts from Asia Minor used to be made in this local stone as well, besides in the imported marble, as evident by a beautiful Corinthian capital from Troesmis. Further detailed studies have shown that the stones for the filling of the walls (emplekton) came from the granite quarries in the area of *Troesmis*.

The first examination and measurements on the marble items took place

in the museum. The object was examined throughout under cold light and UV source and described macroscopically (colored patches, veins, foliation, etc.) Using a magnifying glass and a millimeter scale, the representative maximum grain size (MGSv) of the marble was measured in situ, exploiting all the surface of the objects.

Subsequently powdered samples were taken by using a micro drill machine with diamond driller. Places bearing sculptured artwork or aesthetic and historical information were avoided entirely. In addition, care was taken that the samples were representative for the bulk composition of the marble objects. Stable isotope analysis ($\delta^{18}O$ and $\delta^{13}C$), $^{87}Sr/^{86}Sr$ isotopic analysis and power diffractometric measurements were performed at the laboratory. The analytical results indicate that the raw materials of the investigated white marble objects originate predominantly from the Island Paros (lychnitic and non-lychnitic) and Thasos (Aliki). Some fine grained marbles might come from Penteli, Dokimeion and Miletus. Otherwise, architectural elements in the region are made of Proconnesian marble.

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